

FY 1981

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AQUATIC AND WILDLIFE RESOURCES

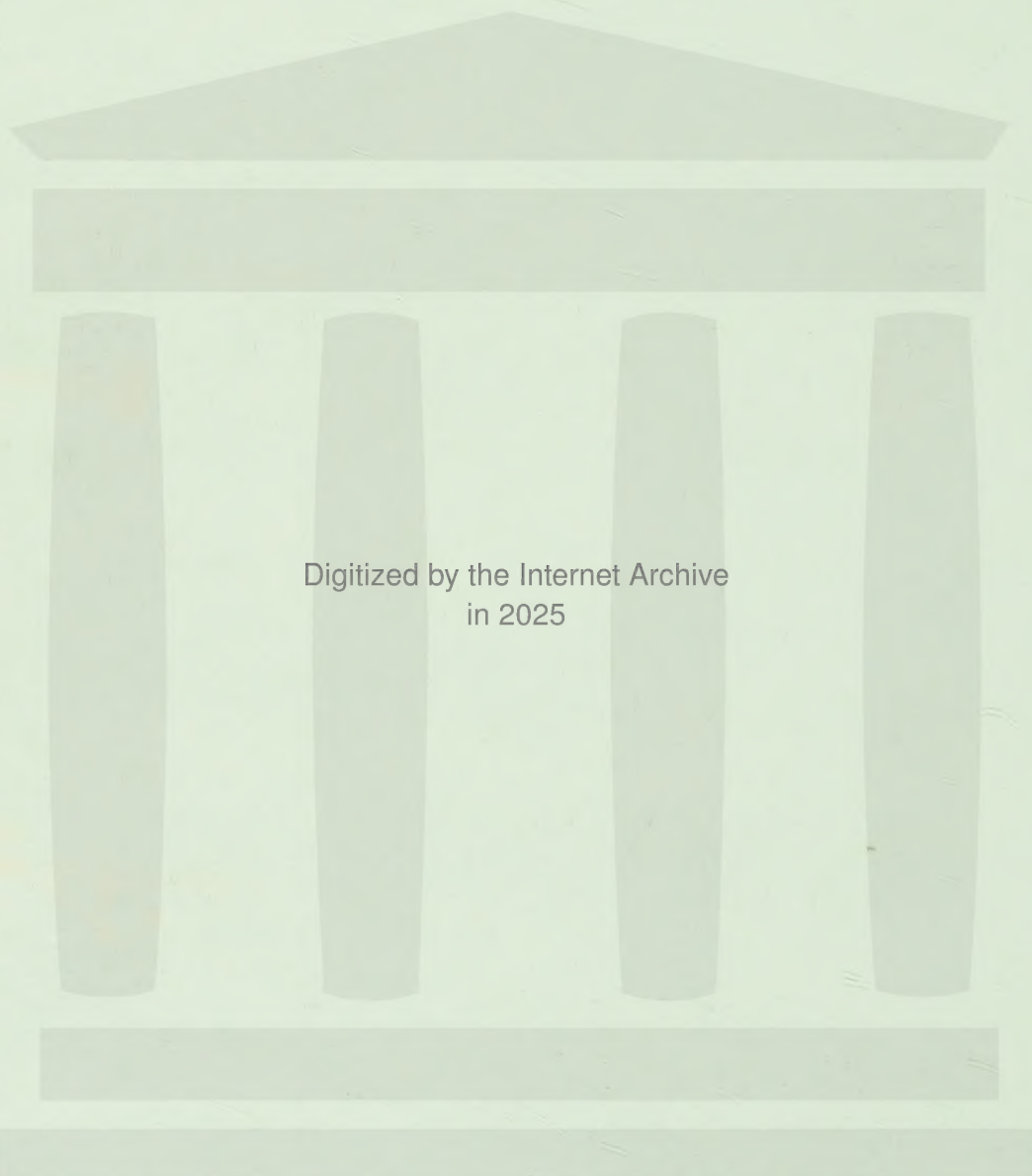


Guam
Aquatic
and
Wildlife
Resources
Annual
Report
FY'81

GUAM
DEPARTMENT OF AGRICULTURE

OCTOBER 1, 1980 - SEPTEMBER 30, 1981

FY ~~1980~~ 1981



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ANNUAL REPORT
FISCAL YEAR 1981

GUAM
AQUATIC & WILDLIFE RESOURCES DIVISION
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DEPARTMENT OF AGRICULTURE
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PERIOD COVERED:
October 1, 1980 to September 30, 1981

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The Cushing Zoo for loaning the Division their Marianas fruit bat for educational displays.

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GUAM FISHERIES INVESTIGATIONS
PROJECT FW-2R-18
Federal Aid in Sport Fish Restoration Act

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-18
SUB-PROJECT NO.: F
STUDY NO.: F-I
JOB NO.: 1

JOB TITLE: Offshore Creel Census

PERIOD COVERED: October 1, 1980 to September 30, 1981

SUMMARY

With exceptions, fishery biologists, censused fish landings for four days each month at Agana Boat Basin and for two days each month at Merizo Pier. The offshore fishing effort is divided among three basic methods: trolling, bottom fishing and spearfishing. The estimated total catches for each method were 67,768.0 Kg, 5359.4 Kg and 956.2 Kg, respectively.

The total estimated catch, for the three methods combined, was 74.08 metric tons. This however applied only to boats fishing from the Agana Boat Basin and Merizo. In addition, there were boats that consistently fished from such locations as Apra Harbor, Agat, Umatac and the Ylig River. Troll fishing trips, from the two censused areas, averaged six boats per day. Our best estimate, which is conservative and consistent with two previous years, is that another four boats per day launched from the other locations combined. Adding a factor of 4/10 to the annual catch figures from Boat Basin and Merizo Pier gives an island-wide total offshore harvest estimate of 123.47 metric tons, which reflects a 23% increase over last year's estimate.

BACKGROUND

Effective management of the island's fishery resources requires accumulating data on fishing pressure, types of fishing methods and annual harvest. To this end, the Division of Aquatic & Wildlife Resources has been conducting offshore fishing interviews with fishermen for more than seventeen years.

OBJECTIVES

- I. To quantify fishing participation, fishing effort and catch, which occurs outside the reef margin in boats.
- II. To collect biological, fish data from specimens examined during fishermen interviews.

PROCEDURES

The creel census effort for FY 81 was somewhat inconsistent due to personnel and funding uncertainties which occurred early in the year. Few censuses were conducted from October, 1980 through February, 1981, however a full complement of censuses were thereafter completed monthly (Table 1).

Table 1. Monthly creel census effort for FY 81 and total number of holidays, weekends and weekdays used in expanding actual data to derive estimated in Tables 3, 5, and 7 (AAB=Agana Boat Basin; MP=Merizo Pier).

Month	No. of Holidays & Weekends	No. of Weekdays	No. of Holidays & Weekends Censused ABB	No. of Holidays & Weekends Censused M.P.	No. of Weekdays Censused ABB	No. of Weekdays Censused M.P.	Total No. of Days Censused
October	9	22	0	0	1	0	1
November	13	17	1	0	2	0	3
December	10	21	1	1	2	0	4
January	10	21	0	0	0	0	0
February	9	19	0	1	0	0	1
March	10	21	2	1	2	1	6
April	9	21	2	1	2	1	6
May	11	20	2	1	2	1	6
June	9	21	3	1	4	1	9
July	9	22	2	1	1	1	5
August	10	21	3	1	1	1	6
September	9	21	2	1	1	1	5

The Agana Boat Basin was censused on two weekdays and two weekends or holidays per month from 1700 hrs. to 2100 hrs. The Merizo Pier was censused from 1200 hrs to 1800 hrs on one weekday and one weekend or holiday. All fishing parties encountered, leaving or returning during the census period, were interviewed.

In addition to the D-J funded creel census, DAWR performed creel census interviews under a subcontract with Survey and Marketing Services, Inc. (SMS), a Honolulu based firm, contracted by the National Marine Fisheries Service (NMFS) to conduct the Pacific portion of the national recreational fishing survey.

There are three major fishing methods employed by offshore anglers on Guam. The most widely practiced of these is multiple-line surface trolling from small, recreational boats, usually less than 30 feet in length. The other two methods are deep-bottom fishing (usually at depths from 100 to 200 fathoms), and nearshore spearfishing at locations which are generally inaccessible to people without the use of boats.

RESULTS

The estimated monthly and annual catch and effort values presented in Tables 3, 5 and 7 are based on the actual data presented in Tables 2, 4 and 6. Estimates are derived from the actual data using the formula:

$$(H/h)(Xh)+(W/w)(Xw) = E;$$

Where H and W are the numbers of holidays and weekdays during the month; h and w are the number of holidays and weekdays censused; X is the actual recorded catch or effort from the censuses; and E is the monthly total estimate of catch or effort. H,h,W and w are found in Table 1. January and February estimates were derived from an average of the data collected in the previous three years.

An estimated 6612 persons spent 42355.0 person-hours trolling 1.3 lines each, during this 12 month report period (Table 3). The species composition of their troll catch was similar to that in the past years and included representatives from the families Carangidae (jacks), Coryphaenidae (dorados), Istiophoridae (billfish), Scombridae (tunas), and Sphyraenidae (barracudas). Approximately 98 percent of the total annual troll harvest, estimated at 67.8 metric tons during FY 81, was accounted for by five major species. By weight these species were skipjack tuna (Katsuwonus pelamis), which constituted 45 percent of the total catch; yellowfin tuna (Thunnus albacares), 27 percent; wahoo (Acanthocybium solandri), 11 percent; billfish (Mikaira nigricans and Istiophorus platypterus), 8 percent; and mahimahi (Coryphena hippurus), 7 percent. The remaining 2 percent of the landings was composed of catches of barracuda (Sphyraena barracuda), rainbow runner (Elagatis bipinnulatus), dogtooth tuna, (Gymnosarda unicolor) and miscellaneous jacks. Although not detected in the data gathering process, more sailfish than usual were caught. One restaurant reported buying six sailfish in two months which is more than they have been able to buy in the "last few years". It should also be noted that the largest mahimahi runs are in January and February, during which creel censuses were not made. In past years mahimahi dominated the overall annual catch. Because the information above is derived from actual data only, the mahimahi catch is underestimated and unreliable.

Table 2. Actual Monthly and Annual Effort, Catch and CPUE Trolling Data collected at the Aqana Boat Basin and Merizo Pier during FY 81.

Month	No. of Boats	Trolling Hours	No. of Persons	Person Hours	No. of Lines	Line Hours	Catch (Kg.)	Catch/ Boat-Hour (Kg.)	Catch/ Person-Hour (Kg.)	Catch/ Line-Hour (Kg.)
October	5	35.4	14	88.4	21	167.0	180.0	5.11	2.05	1.08
November	20	135.7	54	343.9	77	510.3	955.3	7.04	2.98	1.87
December	25	173.9	67	400.7	86	532.0	590.8	3.40	1.47	1.11
January	No Census									
February	No Census									
March	26	170.3	73	483.3	121	805.4	430.7	2.53	0.89	0.53
April	25	146.7	72	405.2	104	594.5	790.9	5.39	1.95	1.33
May	34	211.6	99	598.5	121	738.1	746.6	3.53	1.25	1.01
June	47	268.0	130	741.4	186	1123.4	1315.4	4.91	1.77	1.17
July*	19	101.5	62	315.5	69	356.7	516.8	5.09	1.64	1.45
August	32	169.3	77	392.3	108	570.0	822.9	4.86	2.10	1.44
September	24	122.8	68	347.3	92	477.9	755.3	6.15	2.17	1.58
TOTALS	257	1535.2	716	4116.5	985	5875.3	7105.5	4.63	1.82	1.26

*July 18-20 Marianas Fishing Derby data not included in monthly total.

Table 3. Estimated Monthly and Annual Effort, Catch and CPUE Trolling values, derived from data collected at the Agana Boat Basin and Merizo Pier During FY 81.

Month	No. of Boats	Trolling-Hours	No. of Persons	Person-Hours	No. of Lines	Line-Hours	Catch (Kg.)	Catch/Boat-Hour (Kg.)	Catch/Person-Hour (Kg.)	Catch/Line-Hour (Kg.)
October	144	916.9	442	5300.2	614	7899.3	4773.6	5.21	0.90	0.60
November	227	1431.0	665	3541.6	874	5573.1	9702.7	6.78	2.74	1.74
December	234	1448.4	609	4924.1	782	6594.1	5681.8	3.92	1.15	0.86
* January	141	869.8	569	3644.9	485	3267.4	3497.0	4.02	0.96	1.07
* February	217	1332.9	640	4099.7	863	5818.2	7183.6	5.39	1.75	1.23
March	178	1158.2	485	3175.5	821	5410.6	3431.3	2.96	1.08	0.63
April	154	864.6	482	2564.7	639	3484.5	5039.0	5.83	1.96	1.45
May	183	998.2	594	2879.5	673	3603.3	3448.9	3.46	1.20	0.96
June	206	1215.6	621	3763.1	809	5058.0	8051.7	6.62	2.14	1.59
July	156	838.3	489	2464.9	608	3145.2	6817.9	8.13	2.79	2.17
August	191	1177.7	462	2746.0	731	4596.3	6372.3	5.41	2.32	1.39
September	207	1133.4	554	3250.8	893	4818.6	4867.4	4.29	1.50	1.01
TOTALS	2201	13123.8	6612	42355.0	8792	59268.6	67768.0	5.16	1.60	1.24

* Estimates derived from average of values from previous three years.

The total trolling harvest for this report period was 21.2 metric tons more than that reported during the same time period for FY 80. Although the average catch per person-hour was 27 percent less than the FY 80 figures, the number of boats and anglers participating in the FY 81 offshore trolling was 42 percent and 53 percent more, respectively. The average catch per trolling-hour and the estimated number of trolling-hours by month is shown in Table 3. The average catch per trolling-hour for the year is estimated at 5.2 Kg/boat-hour; an increase from last year's average of only 4.8 Kg/boat-hour.

Most of the fish species caught by trolling are seasonal and primarily caught during their annual migrations past Guam. With the exception of mahimahi, these trends are reflected in the cumulative monthly landings and in individual monthly catch frequencies of the five major species, presented in Table 8. In past years large aggregations of mahimahi were present near Guam between January and April, and subsequently replaced by skipjack tuna for the next five months. Billfish appear in the catches during May through December, and catches of wahoo occur throughout the year. Yellowfin are caught throughout the year, with slightly greater catches occurring between April and August. This is approximately the migration pattern these fish assume each year, but there may be considerable fluctuations in the number and size of fish, and the time of migration.

Bottom Fishing

Tables 4 and 5 present the actual and estimated monthly, effort and catch estimates for FY 81. These estimates were derived from the same projection equation as used for the offshore trolling. The number of boats engaged in bottom fishing is continuing to increase (190 in FY 79, 305 in FY 80, 362 in FY 81). The number of anglers increased from 583 in FY 79 to 898 in FY 81. The total catch, which was down last year, increased in FY 81 to an estimated 5359.4 Kg for Agana Boat Basin and Merizo Pier. Along with the increase in total bottom fish landings, there was an increase in the mean catch/boat, from 9.4 Kg/boat to 14.8 Kg/boat. The catch per line-hour also increased to 1.32 Kg/line-hour.

As last year, the most abundant species caught were lehi (Aphraeus rutilans), uku (Aprion virescens), onaga (Etelis carbunculus), ehu (Etelis marshi), kalikali (Pristipomoides auricilla) and gindai (Tropidinius zonatus), all of which belong to the family Lutjanidae (snappers). Other snappers, and representatives of the jack family (Carangidae), contributed lesser amounts to the total harvest.

OFFSHORE UNDERWATER FISHING ACTIVITIES

Offshore underwater fishing activities include spearfishing, and netting fish while SCUBA diving and snorkeling. Tables 6 and 7 present actual data, and quarterly and annual estimates of catch and effort in these activities. The quarterly estimates were derived from the following formula:

$$(H/h)(A) + (W/w)(B) = E;$$

where H and W are the three-month totals of holidays and weekdays; and h and w are the three-month totals of holiday and weekday censuses; A and B represent the total catch or effort for that three-month period for holidays

Table 4. Actual Monthly and Annual Effort, Catch and CPUE Bottom Fishing Data collected at the Agana Boat Basin and Merizo Pier During FY 81.

Month	No. of Boats	Trolling- Hours	No. of Persons	Person- Hours	No. of Lines	Line- Hours	Catch (Kg.)	Catch/ Boat-Hour (Kg.)	Catch/ Person-Hour (Kg.)	Catch/ Line-Hour (Kg.)
October	0	0	0	0	0	0	0	0	0	0
November	1	2.5	2	5.0	2	5.0	6.1	2.42	1.21	1.21
December	2	12.0	5	27.0	4	24.0	20.2	1.68	0.75	0.84
January	No Census									
February	No Census									
March	2	6.5	3	9.0	3	9.0	1.0	0.15	0.11	0.11
April	1	1.0	3	3.0	3	3.0	1.1	1.10	0.37	0.37
May	6	40.0	17	99.5	15	94.0	113.4	2.84	1.14	1.21
June	19	109.0	45	268.0	48	404.8	373.6	3.44	1.40	0.93
July	9	40.5	23	101.5	20	91.0	151.7	3.75	1.49	1.67
August	11	57.8	29	149.5	26	137.3	278.2	4.81	1.86	2.03
September	7	19.0	18	52.0	15	45.5	108.8	5.73	2.09	2.39
TOTALS	58	288.3	145	714.5	136	813.6	105.5	3.66	1.48	1.30

Table 5. Estimated Monthly and Annual Effort, Catch and CPUE Bottom Fishing Values Derived from Data Collected at the Agana Boat Basin and Merizo Pier During FY 81.

Month	No. of Boats	Trolling Hours	No. of Persons	Person Hours	No. of Lines	Line Hours	Catch (Kg.)	Catch/ Hour (Kg.)	Catch/ Person-hour (Kg.)	Catch/ Line-hour (Kg.)
October	32	124.6	109	461.6	93	452.8	172.9	1.39	0.37	0.38
November	13	32.5	26	65.0	26	65.0	78.7	2.42	1.21	1.21
December	20	120.0	50	270.0	40	240.0	202.0	1.68	0.75	0.84
* January	3	24.1	12	50.8	12	58.4	81.6	3.38	1.60	1.39
* February	8	61.3	14	59.3	16	77.9	167.6	2.73	2.83	2.15
March	28	80.5	49	133.0	49	133.0	20.0	0.25	0.15	0.15
April	7	7.0	21	21	21	21.0	7.7	1.10	0.37	0.37
May	31	193.1	87	463.8	76	439.2	605.4	3.14	1.31	1.38
June	77	433.3	182	1056.5	187	1453.6	1269.2	2.93	1.20	0.87
July	41	182.3	104	456.8	90	409.5	684.0	3.75	1.50	1.67
August	37	192.7	97	498.3	87	457.7	927.3	4.81	1.86	2.03
September	65	102.0	147	267.0	134	237.8	1143.0	11.21	4.28	4.81
TOTALS	362	1553.4	898	3803.1	831	4045.9	5359.4	3.45	1.41	1.32

* Estimates derived from average of values from previous three years.

Table 6. Actual Quarterly and Annual Effort, Catch and CPUE Data for Offshore Underwater Fishing Collected at the Agana Boat Basin and Merizo Pier During FY 81.

Month	No. Boats	Boat-Hours	No. Persons	Person-Hours	Quarterly Catch (Kg.)	Catch/Boat-Hour (Kg.)	Catch/Person-Hour (Kg.)
October November December	1	3.5	2	7.0	9.4	2.69	1.34
January February March	0	0	0	0	0	0	0
April May June	8	32.4	26	105.2	144.0	4.60	1.47
July August September	4	80.0	9	15.5	25.9	5.89	3.42
TOTALS	13	43.9	37	127.7	179.3	4.08	1.40

Table 7. Estimated Quarterly and Annual Effort, Catch and CPUE Values for Offshore Underwater Fishing Activities, Derived from Data Collected at the Agana Boat Basin and Merizo Pier During FY 81.

Month	No. Boats	Boat- Hours	No. Persons	Person- Hours	Quarterly Catch (Kg.)	Catch/ Boat-Hour (Kg.)	Catch/ Person-Hour (Kg.)
October November December	13	45.5	26	91	122.2	2.69	1.34
January February March	2	6.1	11	28.4	15.7	2.57	0.55
April May June	42	131.2	141	487.7	668.4	5.09	1.37
July August September	36	44.8	94	95.0	149.9	3.35	1.58
TOTALS	93	227.6	272	702.1	956.2	4.20	1.36

Table 8. Individual Monthly and Annual Catch Frequencies of the Major and Minor Troll Species landed at Agana Boat Basin and Merizo Pier.

Month	Mahimahi	Wahoo	Skipjack Tuna	Yellowfin Tuna	Dogtooth Tuna	Marlin	Rainbow Runner	Barracuda	Shark Other	Total Kg. For Month
Oct. Total Kg.		2.8		104.0	5.0	60.0		9.0		180.8
% for month		2.0		0.58	0.03	0.33		0.05		
% for year		0.0		0.05	0.40	0.11		0.18		
Nov. Total Kg.	26.3	159.9	701.3	50.0	6.3			5.8	0.5	950.1
% for month	3.0	0.17	0.74	0.5	0.01			0.01	0.00	
% for year	6.0	0.21	0.22	0.03	0.51			0.12	0.01	
Dec. Total Kg.	64.7	140.8	241.7	84.5			4.2			535.8
% for month	12.0	0.26	0.45	0.16			0.01			
% for year	14.0	0.19	0.08	0.04			0.05			
Mar. Total Kg.	279.5	116.9	7.2	41.7				5.4		450.7
% for month	0.62	0.26	0.02	0.09				0.01		
% for year	0.60	0.15	0.00	0.02				0.11		
Apr. Total Kg.	13.5	497.0		267.2					6.4	784.1
% for month	0.02	0.63		0.34					0.01	
% for year	0.03	0.16		0.14					0.10	
May Total Kg.	24.1	71.2	310.0	260.2	0.6	60.0	3.8	5.5	4.9	740.3
% for month	0.03	0.10	0.42	0.35	0.00	0.08	0.01	0.01	0.01	
% for year	0.05	0.09	0.10	0.14	0.05	0.11	0.04	0.11	0.08	
June Total Kg.	37.2	69.8	480.5	485.9		77.8	50.4	7.9	24.7	1234.2
% for month	0.03	0.06	0.39	0.39		0.06	0.04	0.01	0.02	
% for year	0.08	0.09	0.15	0.26		0.14	0.58	0.16	0.38	
July Total Kg.	7.6	3.0	186.3	245.5	0.5	67.3	9.4		0.2	519.8
% for month	0.01	0.01	0.36	0.47	0.00	.13	.02		0.00	
% for year	0.02	0.00	0.06	0.13	0.05	.13	.11		0.00	
Aug. Total Kg.	10.6	45.3	205.5	265.3		272.0	5.2	5.0	14.5	823.4
% for month	0.01	0.05	0.25	0.32		0.33	0.01	.01	0.02	
% for year	0.02	0.06	0.07	0.14		0.51	0.06	.10	0.22	
Sep. Total Kg.	5.9	145.6	529.9	100.0			13.9	11.3	13.8	820.4
% for month	0.01	0.18	0.65	0.12			0.02	0.01	0.02	
% for year	0.01	0.19	0.17	0.05			0.16	0.23	0.21	
Total Kg. by sp. for year	469.4	755.3	3159.4	1904.3	12.4	537.1	86.9	49.9	65.0	7039.7
% of Total Wt.	.07	.11	.45	.27	.00	.08	.01	.01	.01	

or weekdays; and E is the derived three-month estimate.

Ninety-three boats that participated in underwater fishing activities were censused during FY 81; a decrease from FY 80's total of 113 boats. Total catch however, increased from 775 Kg in FY 80 to 956 Kg estimated for Boat Basin and Merizo Pier in FY 81. The catch rate per person-hour was also up from 0.82 Kg to 1.36 Kg.

The major species included in the catch belong to the families Acanthuridae (surgeon fishes), Carangidae (jacks), Holocentridae (squirrel fishes), Kyphosidae (rudder fishes), Labridae (wrasses), and Serranidae (groupers) and octopus. A few Tridacna clams contributed a small amount to the total underwater harvest.

RECOMMENDATIONS

The Western Pacific Fisheries Regional Management Council has proposed a region-wide program of reviewing and coding all past creel census data for incorporation into the Fisheries Information Network (FIN). Guam will participate in this program. The Creel Census Program should be continued on a quarterly basis, and modifications resulting from the region-wide program should be incorporated.

Report prepared by: R. Logan Kock

PROJECT TITLE: Fifth Annual Marianas Fishing Derby

PERIOD COVERED: July 18-20, 1981

INTRODUCTION

The Marianas Fishing Derby (MFD) held on July 18, 19 and 20, 1981 was the most successful to date. Old derby records were broken and new ones were established. As usual, the annual event was sponsored by the Guam Fishing and Boating Association (GFBA). Much of the credit for this year's success should go to the 1981 MFD Committee, chaired by Michael J. Reidy. The fishery biologists from Aquatic and Wildlife Resources (AWR) are grateful to the committee for their thoughtful organization and assistance in making our job at the derby more enjoyable. The cooperation extended to us by the participating anglers also helped make our work much easier.

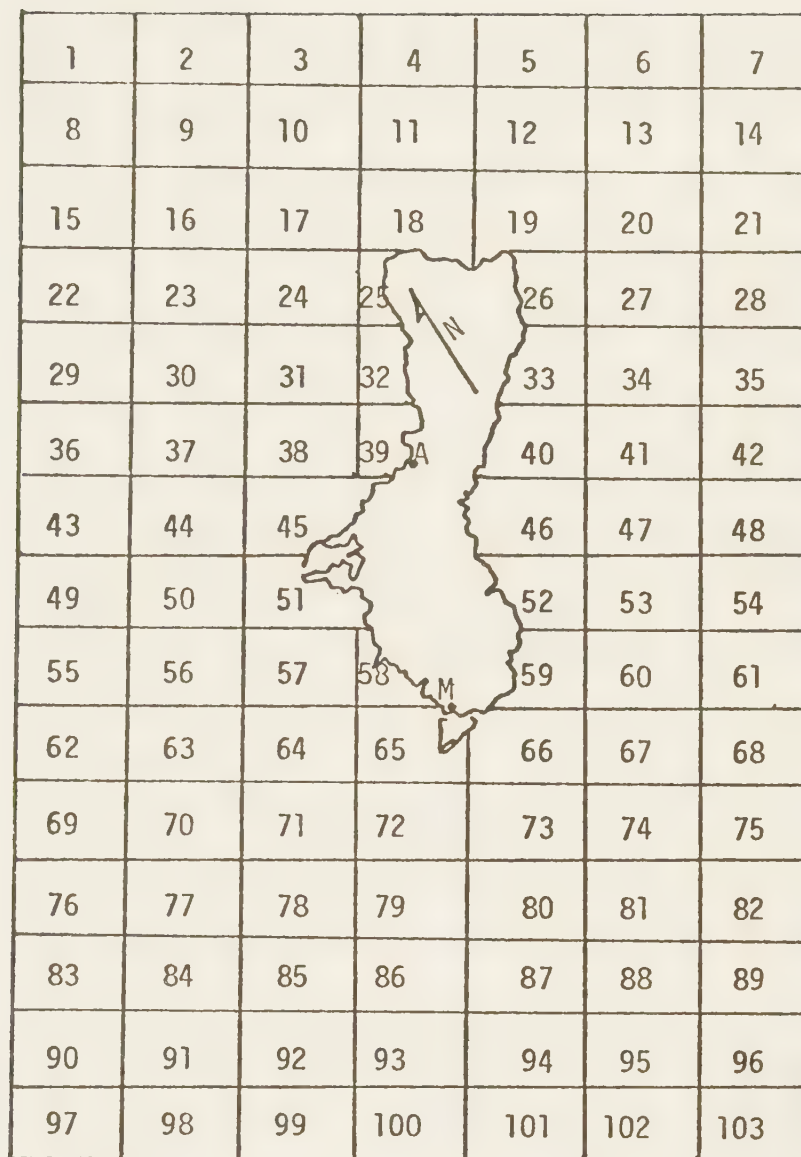
As in past derbies, awards were presented to the anglers who landed the first, second and third heaviest fishes of the following species: blue marlin (Makaira nigricans), yellowfin tuna (Thunnus albacares), wahoo (Acanthocybium solandri) and mahimahi (Coryphaena hippurus). A significant change was instituted this year with the addition of a new prize category for "Other Species". A first place award was given to the angler who caught the heaviest fish that was not one of the four principal contest species. A first place award was also given for the largest total number of fishes caught, based on the four principal contest species only.

PARTICIPATION

This year onshore derby stations were established at the Agana Boat Basin and Merizo Pier (Figure 1). The purpose of having two stations was to make it easier for competing anglers to fish both the northern and southern fishing grounds of Guam. Similar attempts to provide this option during the first two MFD's (1977 and 1978) proved to be difficult to carry out efficiently. As a result, only the Agana Boat Basin station was set up for the third and fourth derbies (1979 and 1980). The efficient organization and guidance of this year's MFD Committee, along with the cooperation of the village of Merizo and the government of Guam, made the successful operation of both stations possible in 1981.

Information on the daily participation at these locations is presented in Table 1. A total of 185 separate boat trips was recorded during this year's contest with 80% of these trips originating from the Agana Boat Basin. Each boat carried approximately three anglers and pulled an average of four trolling lines per trip, which has been fairly consistent throughout the history of the derby. By contrast, dramatic increases were noted this year in both the mean daily number of persons participating (Figure 2) and the mean number of boat trips made per day (Figure 3).

A corresponding increase in the mean length of fishing trip was also observed during the 1981 MFD (Figure 4). Although this information is not available for the first derby, the mean lengths of fishing trips have been increasing steadily since 1978. Altogether, this year's participants spent an estimated 6,098 person-hours of fishing effort during the derby. Fishing effort may also be considered in terms of "soaking time", or the amount of time in which fishing lines were being trolled. This year's estimated soaking time totaled 7,813 line-hours.



FISHING AREA NUMBERS;
 FILL IN ON OTHER SIDE
 GRID SCALE:
 APPROX. 5 mi. x 8 mi.
 4 = Rota Bank
 12 = 45° Bank
 24/25 = Ritidian Pt.

19 = Pati Pt.
 39 = Hospital Pt.
 51 = Orote Pt.
 70 = 11mi. (17mi.) Reef
 85 = Galvez Bank
 92 = Baby Banks
 100 = Santa Rosa Reef

Figure 1. The island of Guam with MFD fishing areas.
 A = Agana Boat Basin; M = Merizo Pier.

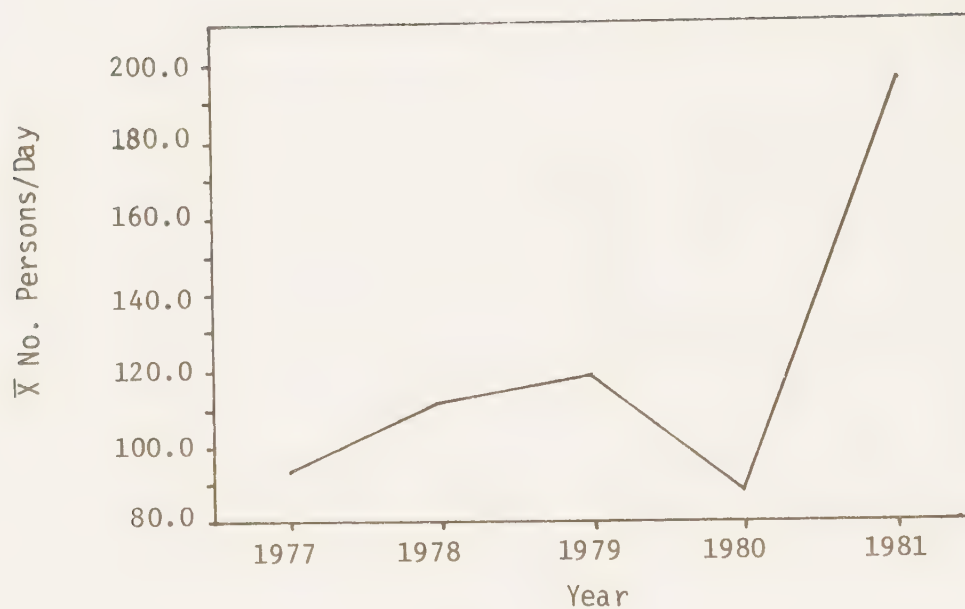


Figure 2. Five-year MFD mean daily participation.

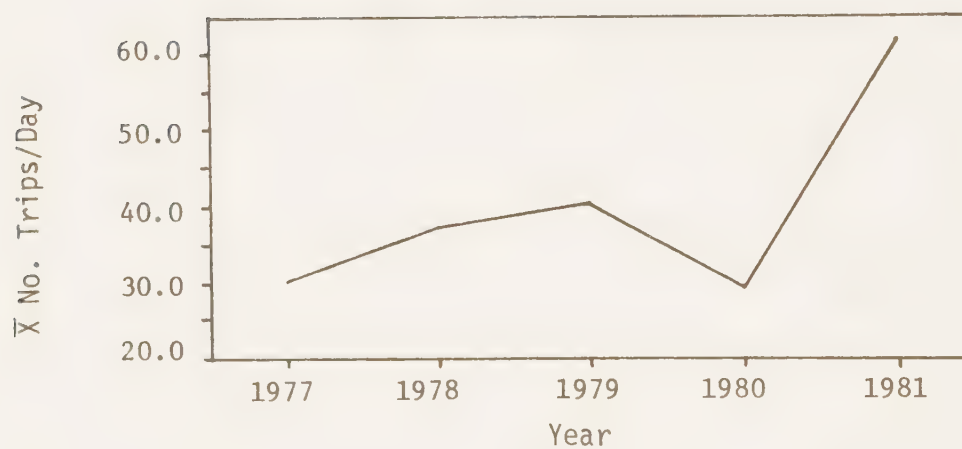


Figure 3. Five-year MFD mean daily number of boat trips.

Table 1. Daily participation in the 1981 Marianas Fishing Derby (MFD).

Date	No. Boats	No. Trips	Avg Trip Hrs.	No. Persons	Avg Pers/Trip	No. Lines	Avg Lines/Trip
AGANA:							
18 July	49	50	10.6	166	3.3	200	4.0
19 July	47	48	10.5	157	3.3	192	4.0
20 July	49	50	10.0	136	2.7	204	4.1
TOTAL	145	148	10.2	459	3.1	596	4.0
MERIZO:							
18 July	16	16	11.1	51	3.2	69	4.3
19 July	8	8	9.1	33	4.1	34	4.2
20 July	13	13	10.5	41	3.1	57	4.4
TOTAL	37	37	10.5	125	3.4	160	4.3
COMBINED TOTAL	182	185	10.3	584	3.2	756	4.1

Table 2. Daily catch for the 1981 MFD.

Date	Blue Marlin		Yellowfin		Wahoo		Mahimahi		Other Species		Total	
	No.	Kg.	No.	Kg.	No.	Kg.	No.	Kg.	No.	Kg.	No.	Kg.
AGANA:												
18 July	8	535.9	12	123.8	9	74.0	0	0.0	32	92.1	61	825.8
19 July	11	647.2	5	95.1	18	165.3	0	0.0	15	34.2	49	941.8
20 July	6	321.7	21	243.5	11	83.8	1	0.8	27	62.7	66	712.5
TOTAL	25	1504.8	38	462.4	38	323.1	1	0.8	74	189.0	176	2480.1
MERIZO:												
18 July	2	123.2	58	555.5	13	131.0	0	0.0	31	114.4	104	924.1
19 July	5	264.5	2	28.7	8	74.8	0	0.0	4	11.9	19	379.9
20 July	2	112.5	11	109.7	1	14.2	0	0.0	32	47.6	46	284.0
TOTAL	9	500.2	71	693.9	22	220.0	0	0.0	67	173.9	169	1588.0
COMBINED TOTAL	34	2005.0	109	1156.3	60	543.1	1	0.8	141	362.9	345	4068.1

The Catch

A total of 345 fish weighing 4,068.1 Kg was censused at the 1981 MFD. This total includes the weight of the "Other Species" category as well as that of the four principal derby species. Table 2 summarizes the recorded daily catch for the two derby landing sites.

More than three times as many blue marlin were caught this year than in any of the previous derbies. The 34 individuals weighed 2005.0 Kg, and had a weight range between 33.8 Kg and 145.4 Kg, with a mean weight of 59.0 Kg.

The yellowfin tuna catch was also good this year with 109 individuals weighing 1156.3 Kg. They ranged in weight from 2.8 Kg to 47.7 Kg, and had a mean weight of 10.6 Kg.

A total of 543.1 Kg of wahoo was landed which had a weight range of 5.6 Kg to 17.0 Kg. The mean weight for the 60 individuals was 9.0 Kg.

Only one mahimahi was brought in this year and it tipped the scale at a remarkable 0.8 Kg.

The "Other Species" category included 141 fishes that weighed a total of 362.9 Kg. By weight, 33.8% of these were rainbow runners (Elagatis bipinnulatus), 24.8% were barracuda (Sphyraena barracuda), 24.4% were skipjack tuna (Katsuwonus pelamis), 5.2% were dogtooth tuna (Gymnosarda nuda), and the remaining 11.8% were composed of lehi (Aphareus rutilans), uku (Aprion virescens), and other small tunas. The prize for the "Other Species" category went to an angler who caught a 12.0 Kg dogtooth tuna. The "Total Catch" prize was awarded to the captain of a Merizo-based charter boat for landing 31 fish during the derby.

No previous records for individual weights of the four principal derby species were broken this year. The weights of all the winning fishes from the past five derbies are presented in Table 3. The heaviest blue marlin and yellowfin tuna were caught during the third MFD in 1979, while the record wahoo and mahimahi were landed during the fourth MFD in 1980.

Over the past five years, the mean weight of catch per boat trip has been increasing steadily (Figure 5). This increase may be attributed largely to an overall increase in effort. In Figure 5 our data show a very high mean catch for the first MFD, but we believe this to be unrepresentative of the total expended effort. This high value may be explained by the fact that it is based only upon 26% of the boats which participated that year. This percentage represents the number of boats for which a daily activity form was received upon their return to port. In subsequent derbies the rules have stated that all boats must submit a daily activity form after each outing. The forms we received in 1977 were submitted by anglers who felt they had caught a fish large enough to win a prize. Thus, the mean for that year is biased in favor of the catches that included larger fishes.

SEX RATIO

This year sex determinations were made on 61 blue marlin, yellowfin tuna and wahoo. The results of these examinations are provided in Table 4. While the male:female ratios for yellowfin and wahoo were found to be within the realm of expectation (2.0:1 and 1.1:1, respectively), the blue marlin ratio was surprisingly high at 12.0:1. The large number of males in the blue marlin catch was particularly surprising since in the four previous derbies the ratio for that species and for yellowfin tuna have been very close. These data, and those for wahoo and mahimahi are summarized in Table 5.

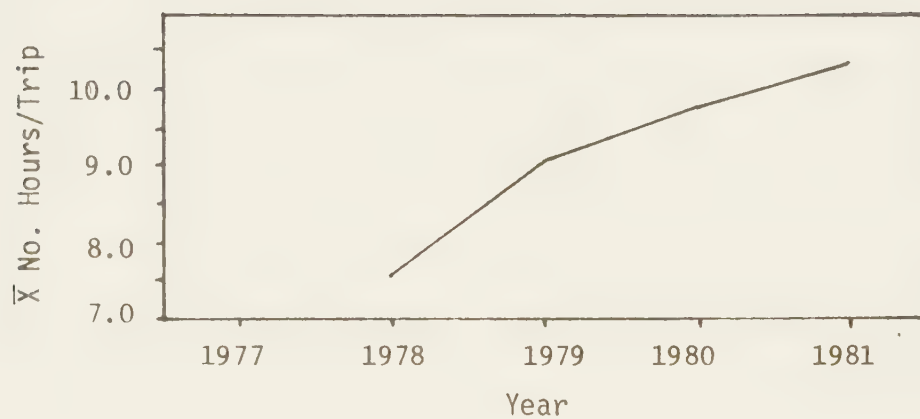


Figure 4. Five-year MFD mean lengths (hr) per boat trip.
No data available for 1977.

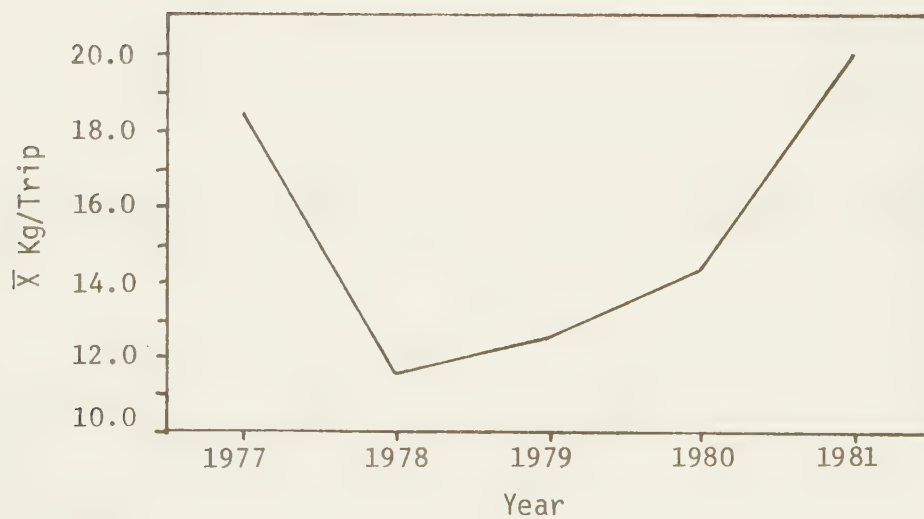


Figure 5. Five-year MFD mean catch (Kg) per boat trip.

Table 3. Winning fishes caught during the first five MFD's. Weights are expressed in kilograms.

SPECIES	1977	1978	1979	1980	1981
Blue Marlin	192.4	75.2	237.5	139.3	145.4
Yellowfin	46.3	56.8	67.7	51.1	47.7
Wahoo	22.3	18.9	19.7	23.4	17.0
Mahimahi	8.9	8.9	14.8	15.9	0.8
"Other Spp": Dogtooth Tuna					12.0

Table 4. Sex ratios and mean weights for 61 fish examined during the 1981 MFD.

SPECIES	MALES		FEMALES		RATIO Male : Female
	No.	$\bar{x}$ Kg	No.	$\bar{x}$ Kg	
Blue Marlin	24	53.6	2	140.8	12.0 : 1
Yellowfin	12	16.2	6	23.0	2.0 : 1
Wahoo	9	9.9	8	7.5	1.1 : 1

Table 5. Male:Female sex ratios by species determined during the first five MFD's. Sample sizes are indicated in parentheses.

YEAR	BLUE MARLIN		YELLOWFIN		WAHOO		MAHIMAHI	
1977	0.6 : 1	(8)	1.0 : 1	(6)	All Female	(6)	All Female	(2)
1978	All Male	(9)	All Male	(15)	2.0 : 1	(6)	All Female	(4)
1979	1.0 : 1	(6)	1.0 : 1	(22)	0.4 : 1	(11)	All Female	(5)
1980	4.5 : 1	(11)	4.2 : 1	(21)	0.2 : 1	(11)	0.5 : 1	(3)
1981	12.0 : 1	(26)	2.0 : 1	(18)	1.1 : 1	(17)	None	(0)
TOTAL	4.0 : 1	(60)	2.4 : 1	(82)	0.5 : 1	(51)	0.1 : 1	(14)

While there have consistently been more males than females in the blue marlin and yellowfin catches over the past five years, the wahoo and mahimahi catches have been dominated by females. This becomes even more interesting when the sex ratios are viewed in relation to the yearly fluctuations of the mean weights of these species (Figs. 6 and 7). During years when the mean weights of blue marlin have been relatively high, more females than males have been present in the catches. This relationship is the strongest for blue marlin, but also appears to exist for yellowfin tuna. The wahoo catches have also shown this relationship but to a lesser degree. Our data on mahimahi suggest just the opposite relationship. In five years only one male has been censused in derby catches and that occurred in 1980 when the mean weight for mahimahi was at its highest point in MFD history.

FISHING AREAS

Table 6 summarizes the 1981 MFD catch by species, date and strike area. The areas listed in this table may be located in Figure 1 for a more complete picture.

Exclusive of the blue marlin category, all of the winning catches were made on Guam's southern fishing banks. Both the winning yellowfin tuna and wahoo, as well as the dogtooth tuna that took the "Other Species" prize, were hooked in Area 85 (Galvez Banks). In addition, this area produced all the fish for which the "Total Catch" award was given. The sole mahimahi landed this year was caught in Area 100 (Santa Rosa Reef), while the only prize that went for a fish caught in northern waters was for a blue marlin hooked in Area 29.

By overall weight and numbers, respectively, this year's most productive areas were Area 85 (19.8% and 29.8%) and Area 100 (9.0% and 11.9%). Area 4 (Rota Banks) in the north produced only a relatively fair catch in terms of numbers (7.6%) and even less in terms of weight (4.0%).

STOMACH CONTENTS

The stomach contents of 25 blue marlin, 19 yellowfin tuna and 19 wahoo were examined. Each stomach was dissected from the fish immediately after weighing and measuring. Its contents were sorted on a table, counted and identified to the finest possible taxonomic unit. Selected dietary items were preserved in a 10% formaldehyde solution and/or photographed for future identification. Stomach wall parasites were also recorded in the same manner.

All of the blue marlin stomachs contained identifiable material. Fishes made up 90.9% of the identifiable prey items and occurred in 96.0% of the stomachs (Table 7). Cephalopods, primarily the squid Loligo sp, made up only 9.2% of the total food items, but occurred in 64.0% of the stomachs. At least 31 species of prey fishes were distinguishable. The most important in terms of numbers were ee (juvenile Caranx sp.) and post-larval acanthurids (at least two species). The largest prey items were adult skipjack tuna (Katsuwonus pelamis), opelu (Decapterus spp.(2), up to 300+mm TL) and atulai (Selar crumenophthalmus), which made up a combined total of only 2.4% of the identifiable prey. Other important prey items included juvenile goatfish Mulloidichthys sp, post-larval balistids, monacanthids and ostraciontids, and juvenile lutjanids (Aphareus sp, Pterocaesio sp.).

All of the yellowfin tuna stomachs contained identifiable prey items. Fishes made up 72.7% of the items and occurred in every stomach. These were followed by crustaceans which made up 20.5% of the contents and occurred in 56.0% of the stomachs, and cephalopods which made up 6.9% of the contents and occurred in

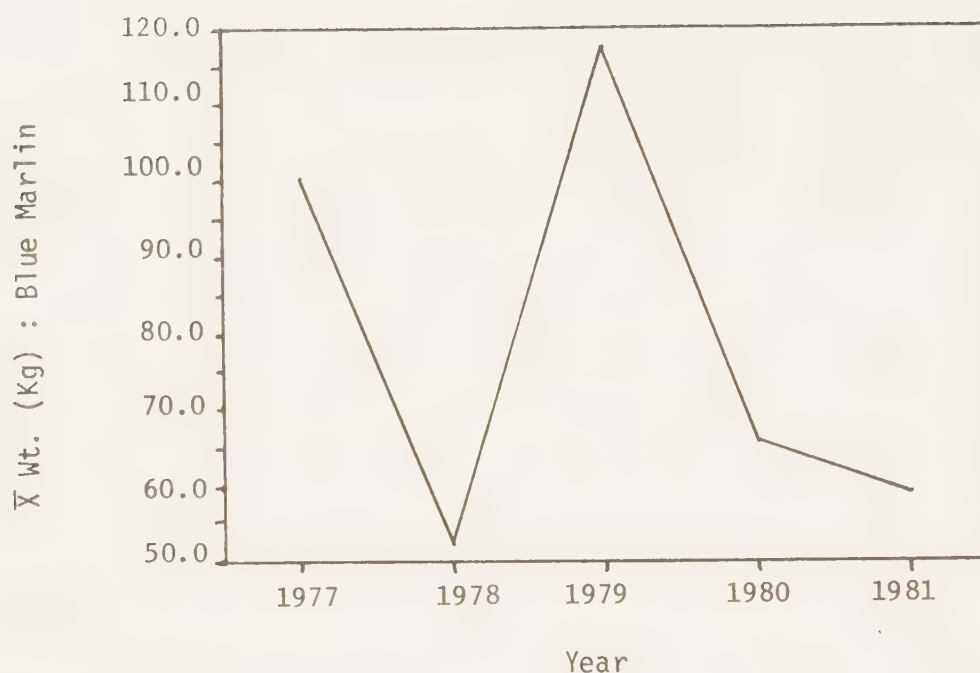


Figure 6. Five-year MFD mean weights of blue marlin.

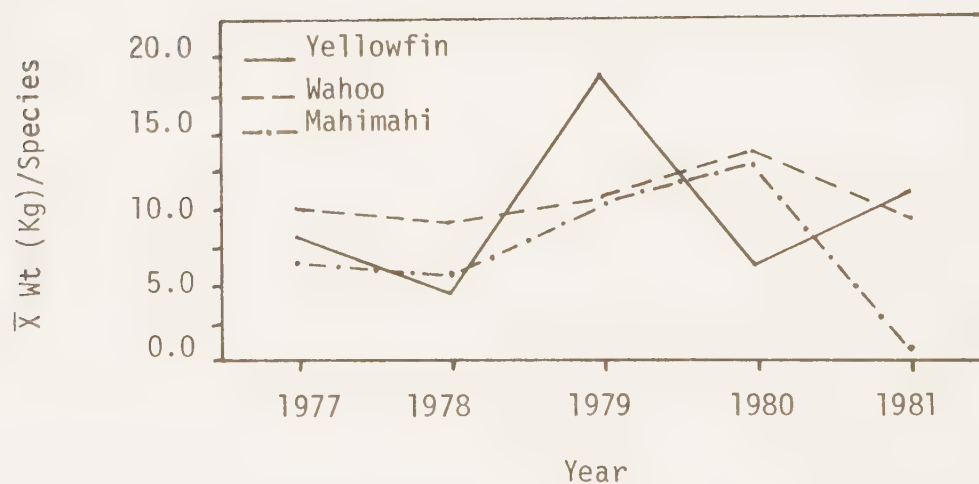


Figure 7. Five-year MFD mean weights of yellowfin tuna, wahoo and mahimahi.

Table 6. Number of fishes caught during the 1981 MFD by species, date and area of catch (Also see Fig. 1). This table includes only those fishes for which area data were recorded.

AREAS:	3	4	5	9	10	11	12	17	18	19	22	24/25	29	30	31	32
BLUE MARLIN:																
18 July	-	-	-	-	-	-	-	-	-	-	-	1	1	1	-	-
19 July	1	1	1	-	-	1	-	1	-	-	-	-	-	1	1	1
20 July	-	-	-	-	-	-	1	-	-	1	1	1	1	-	-	-
TOTAL	1	1	1	-	-	1	1	1	-	1	1	2	2	2	1	1
AVG. WT. (Kg)	37.9	50.1				136.3	52.3	39.0			41.4	46.8	109.8	55.3	55.9	48.8
YELLOWFIN:																
18 July	-	-	-	-	1	-	4	-	-	1	-	3	-	-	-	-
19 July	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-
20 July	3	-	-	-	-	-	8	-	2	3	-	-	-	-	-	-
TOTAL	3	-	-	-	1	-	12	-	2	4	-	6	-	-	-	-
AVG. WT. (Kg)	16.5				20.5		10.5		3.8	6.8		12.6				
WAHOO:																
18 July	1	-	-	-	-	-	-	-	-	1	-	3	-	-	-	-
19 July	-	1	2	-	-	5	-	5	-	4	-	1	-	-	2	2
20 July	-	1	-	-	-	-	8	-	4	2	-	2	-	-	-	-
TOTAL	1	2	2	-	-	5	12	5	4	7	-	6	-	-	2	2
AVG. WT. (Kg)	13.6	7.6	6.3			9.1	10.5	9.1	6.6	9.4		7.2			6.4	6.4
MAHIMAH:																
18 July	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
19 July	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20 July	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
AVG. WT. (Kg)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
OTHER SPECIES:																
18 July	10	-	-	-	-	7	-	-	-	-	-	-	-	-	1	1
19 July	-	-	-	-	-	-	-	-	-	9	-	-	-	-	-	-
20 July	7	-	-	-	-	1	-	-	18	5	-	-	-	-	-	-
TOTAL	17	-	-	-	-	8	-	-	18	14	-	-	-	-	1	1
AVG. WT. (Kg)	3.3					2.0			2.2	2.8					4.4	4.4
No. Caught	1	23	1	2	1	1	21	6	24	25	1	14	2	2	2	3
% Total No.	0.3	7.6	0.3	0.7	0.3	0.3	7.0	2.0	8.0	8.2	0.3	4.6	0.7	0.7	0.7	1.0
Kg. Caught	13.6	157.7	50.1	12.5	20.5	136.3	194.2	84.4	73.8	132.1	41.4	212.7	219.6	110.7	60.3	61.7
% Total Kg	0.3	4.0	1.3	0.3	0.5	3.5	4.9	2.2	1.9	3.4	1.0	5.4	5.6	2.8	1.5	1.6

Table 6. (Cont.)

AREAS:	37	38	39	44	45	51	70	72	73	77	85	92	100	TOTAL
BLUE MARLIN:														
18 July	-	-	4	-	-	-	1	-	-	1	-	1	-	10
19 July	-	3	-	-	-	-	1	1	-	-	3	-	1	16
20 July	2	-	-	-	-	-	-	1	1	-	-	-	-	8
TOTAL	2	3	4	-	-	-	2	2	1	1	3	1	1	34
AVG. WT. (Kg)	55.7	54.5	58.2	-	-	-	55.6	62.2	55.0	54.8	44.0	68.4	65.7	59.0
YELLOWFIN:														
18 July	-	-	-	-	-	-	8	-	-	-	31	-	22	70
19 July	-	1	-	-	-	-	-	-	-	-	2	-	-	6
20 July	-	-	-	2	-	-	-	-	-	-	10	-	-	28
TOTAL	-	1	-	2	-	-	8	-	-	-	43	-	22	104
AVG. WT. (Kg)	-	14.5	-	14.7	-	-	15.4	-	-	-	8.8	-	12.3	9.9
WAHOO:														
18 July	-	-	-	-	-	-	-	-	-	-	16	-	1	22
19 July	1	1	-	-	-	1	1	-	-	-	4	4	-	26
20 July	-	-	-	1	1	-	-	-	-	-	1	-	-	12
TOTAL	1	1	-	1	1	1	1	-	-	-	21	4	1	60
AVG. WT. (Kg)	10.9	-	-	12.2	8.5	17.4	13.4	-	-	-	12.3	10.4	7.3	9.2
MAHIMAH:														
18 July	-	-	-	-	-	-	-	-	1	-	18	1	11	54
19 July	2	-	-	-	-	-	-	-	-	-	4	1	-	16
20 July	-	-	-	-	-	-	-	-	-	-	1	-	-	33
TOTAL	2	2	-	-	-	-	5	1	1	-	23	2	11	103
AVG. WT. (Kg)	2.0	2.0	-	-	-	-	1.5	1.3	6.5	-	3.3	2.6	4.2	2.9
OTHER SPECIES:														
18 July	-	6	5	1	3	1	16	3	2	1	90	7	36	302
19 July	2.0	2.0	1.7	0.3	1.0	0.3	5.3	1.0	0.7	0.3	29.8	2.3	11.9	100.0
% Total No.	0.7	-	-	-	-	-	-	-	-	-	-	-	-	-
Kg Caught	111.5	178.4	247.3	12.2	37.9	17.4	255.0	125.6	61.5	54.8	780.1	115.1	353.4	3932.8
% Total Kg	2.8	4.5	6.3	0.3	1.0	0.4	6.5	3.2	1.6	1.4	19.8	3.0	9.0	100.0

Table 7. Stomach contents of 63 fishes caught during the 1981 MFD. "% total" represents the % of the total number of stomach content items in all stomachs of that species; "% stomach" represents the % of the stomachs containing that particular item. Symbols: * = post-larvae only; @ = identification tentative, previously unreported from Guam; + = more than the listed amount was present, but not counted.

SPECIES:	<u>BLUE MARLIN</u>		<u>YELLOWFIN TUNA</u>		<u>WAHOO</u>	
Stomach Contents	% Total	% Stomachs	% Total	% Stomachs	% Total	% Stomachs
Fishes						
<u>Stolephorus</u> sp.	3.2	16.0	3.7	21.1	24.1	10.5
<u>Exocoetidae</u>					2.8	15.8
<u>Belonidae</u>	1.0	20.0	1.7	5.3		
* <u>Adioryx</u> , sp.	1.3	8.0	4.2	5.3	1.9	10.5
<u>Hippocampus</u> sp.			0.3	5.3		
<u>Priacanthus</u> sp.	0.2	4.0				
<u>Caranx</u> sp.	22.3	72.0	0.3	5.3	0.9	5.3
<u>Decapterus</u> sp. 1	0.6	8.0				
<u>Decapterus</u> sp. 2	0.4	4.0				
<u>Selar crumenophthalmus</u>	1.2	16.0				
<u>Carangidae</u> sp. 1	0.4	4.0				
<u>Carangidae</u> sp. 2	0.2	4.0				
<u>Bramidae</u>	0.2	4.0				
<u>Aphareus</u> sp.	1.0	16.0	0.6	5.3		
<u>Pterocaesio</u> sp.	1.9	12.0	0.8	15.8		
<u>Mulloidichthys</u> sp.	3.8	12.0	0.8	5.3		
* <u>Chaetodontidae</u>	0.4	4.0	1.1	10.5		
<u>Sphyraena</u> sp.	0.2					
<u>Xiphasia setifer</u>					0.9	5.3
* <u>Acanthurid</u> spp.	22.5	80.0	21.4	52.6	43.5	15.8
* <u>Zanclus cornutus</u>	0.2	4.0	3.7	5.3	4.6	10.5
<u>Gempylidae</u>	0.4	4.0				
<u>Katsuwonus pelamis</u>	0.2	4.0				
* <u>Balistidae</u> spp.	11.6	28.0	5.0	21.0	3.7	15.8
* <u>Monacanthidae</u> spp.	1.3	16.0	0.6	10.5		
@* <u>Lactoria diaphanus</u>	1.7	12.0	15.5	47.4		
<u>Lagocephalus lagocephalus</u>	0.2	4.0	0.3	5.3		
* <u>Tetradontidae</u> spp.	0.2	0.4	0.6	5.3		
@ <u>Masturus lanceolatus</u>	0.2	0.4				
<u>Unid. fishes</u>	14.1	40.0	12.1+	63.2	12.0+	57.9
Total Fishes	90.9	96.0	72.7	100.0	94.4	84.2

Table 8. Percent of fishes containing empty stomachs examined during the first five MFD's. Sample sizes are indicated in parentheses.

YEAR	BLUE MARLIN		YELLOWFIN		WAHOO		MAHIMAHI		TOTAL	
1977	60.0	(5)	0.0	(3)	83.3	(6)	100.0	(2)	62.5	(16)
1978	0.0	(9)	0.0	(14)	33.3	(6)	25.0	(4)	12.1	(33)
1979	16.7	(6)	13.6	(22)	54.5	(11)	0.0	(5)	22.7	(44)
1980	18.2	(11)	0.0	(21)	9.1	(11)	0.0	(2)	6.7	(45)
1981	0.0	(25)	0.0	(19)	15.8	(19)	-	(0)	4.8	(63)
TOTAL	10.7	(56)	3.8	(79)	32.1	(53)	30.8	(13)	14.9	(201)

42.1% of the stomachs. At least 19 species of fishes were distinguishable. The most important were post-larval acanthurids and ostraciontids. Other important fishes included engraulids (Stolephorus sp.), and post-larvae of Adioryx sp., Zanclus cornutus and balistids. The major crustacean prey found in the yellowfin stomachs were shrimp and stomatopods. Squid were the major cephalopod prey.

All but three of the 19 wahoo stomachs contained identifiable prey. As in the previous species, fishes were the most important prey, comprising 94.4% of the identifiable contents and occurring in 84.2% of the stomachs. Molluscs (3.8% of contents, in 10.5% of stomachs) and crustaceans (1.9% of contents, in 10.5% of stomachs) were relatively unimportant prey. At least nine species of fish were distinguishable. The most important were post-larval acanthurids and engraulids. Other important fishes included flying fishes (Exocoetidae), and post-larval Zanclus cornutus and balistids.

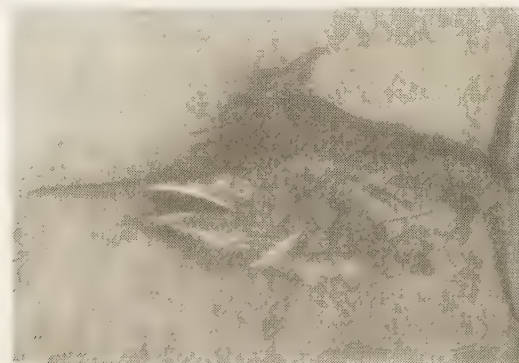
At least three types of parasites were identified in this year's stomach samples. The most frequently encountered parasite was the trematode Hirundinella sp. which occurred in 48.0% of the blue marlin stomachs and 89.5% of the wahoo stomachs. The yellowfin tuna were free of parasites.

This year only 4.8% of the examined stomachs were found to be empty. This represents the least number of empty stomachs that we have encountered at any MFD (Table 8). In all, 201 stomachs have been checked from the four principal derby species during the past five contests. Only 14.9% of these were found to be empty. The majority of the empty stomachs have been from wahoo and mahimahi, while the least number of empty stomachs have been found within the yellowfin and blue marlin catches.

Fishes far exceeded all other prey items in the stomachs of this year's catch, both in numbers and frequency of occurrence. Our MFD research over the years has consistently showed fishes to be the most ubiquitous prey item found, particularly among the blue marlin, wahoo and mahimahi. It is notable that the majority of prey fishes were either juveniles or post-larvae of inshore shallow-water coral reef species, trophically linking pelagic game fishes with the coral reef ecosystem. In cases where large, pelagic species were consumed (eg. K. pelamis), it is reasonable to assume that they in turn fed on inshore, coral reef-linked species. Among the yellowfin tuna, however, pelagic crustaceans assume a more important role as food than they do among the other three derby species.

Stomach content section prepared by Robert F. Myers.

Report prepared and edited by Michael E. Molina.



The blue marlin is one of Guam's most prized game fish.

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-18
SUB-PROJECT NO.: F
STUDY NO.: F-I
JOB NO.: 2

JOB TITLE: Inshore Creel Census

PERIOD COVERED: October 1, 1980 to September 30, 1981

SUMMARY

During FY81 there was no census effort for the month of October and only partial effort within the months of November through January. Three shoreline routes were censused twice per month from November to January. An estimated 8131 kg of finfish were caught. Hook and line fishing was the most popular method accounting for 65% of the gear-hours. Surround netting yielded approximately 52% of the total yearly catch. Other major inshore fishing methods include cast netting, gill netting, and spearfishing.

BACKGROUND

Effective management of Guam's fishery resources requires accumulating data on fishing pressure, types of fishing methods, and annual harvest. To this end, the Division of Aquatic and Wildlife has been conducting inshore fishing interviews with fishermen for the past seventeen years.

OBJECTIVES

- I. To monitor trends in types and results of different fishing methods, areas fished, and types and number of each species taken for inshore fishing activities. This information will be made available to fishermen to improve their catches.
- II. To chart variations in standing crop, species composition, and/or distribution patterns for various fishing areas, and to determine if these variations occur in a seasonal or otherwise predictable manner.
- III. To make annual estimates of the total fish catch for Guam.
- IV. To create a table of length/weight conversion constants for Guam's inshore game fishes.

PROCEDURES

Inshore creel census interviews were conducted during the 1981 report period (October 1980 - September 1981). Due to funding and personnel uncertainties there was no census effort for the month of October and only partial effort was maintained during the months of November through January. Censuses were taken along three shoreline routes, which include fishing areas for heaviest fishing pressure (Figure 1). Each route was censused twice per month (once on a weekday and once on a holiday), except when prevented by weather conditions or personnel shortages. Dates were chosen by lottery, and no two routes were censused on the same day.

RESULTS

The major inshore fishing methods include hook and line fishing, cast netting, gill netting, surround netting, and spearfishing. In addition, octopi, lobsters, crabs, and shellfish, were harvested by hand or with hooks and short spears.

Actual censused data for each fishing method are presented in Tables 1a-5a. Expansions from these data to obtain total, annual estimates are presented in Tables 1b-5b. Estimated values were derived by computing mean catch and effort values for both weekdays and holidays, respectively for each month and multiplying these values by the number of weekdays and holidays, respectively, for each month. Table 6 summarizes the catch and effort data by fishing method for FY81. Table 7 summarizes inshore creel census effort done monthly along the three shoreline routes. Due to the inconsistencies in sampling effort our estimates of total fishing pressure and catch are not as reliable as those of previous years. These estimates will be revised upon completion of the current analyses of past (5 years) creel census data.

An estimated total of 8131 kg of finfish was caught through the use of all five of the major inshore fishing methods in FY81 (Table 6). This catch resulted from a total effort of 28,957 person-hours or 18,821 gear-hours. Approximately 0.28 and 0.43 kg of fish were taken per person-hour and gear-hour, respectively. Over ninety species of fish from twenty-five families were represented in the catch. However, surgeon fish (Acanthuridae), jacks (Carangidae), rabbitfish (Siganidae), goatfish (Mullidae), and mullet (Mugilidae), were by far the most abundant.

As in previous years, hook and line fishing was the most popular method, accounting for 44.2% of the total person-hours and 65% of the total gear-hours. Success with hook and line gear still remains lower than any other fishing method, averaging 0.13 kg per fishing hour. This method produced 1614 kg, or approximately 20% of the total yearly catch. The greatest effort and largest catch for hook and line occurred in the late summer and early fall (Figure 2). This increase was mainly due to atulai (Selar crumenophthalmus) caught at Agana Boat Basin, where an estimated 1000 kg was caught. This represents approximately 62% of the total catch for this method.

Cast netting, a traditional method of fishing, accounted for approximately 14% of the total fishing effort and 11% of the total catch (Table 6). The catch-per-unit-effort for this method averages 0.32 per gear-hour and 0.21 per person-hour.



Figure 1. The island of Guam. The Inshore Fishing Census Regions are as follows: Region #1 - Gun Beach to Adelup Pt.
Region #2 - Adelup Pt. to Nimitz Beach
Region #3 - Toguan Bay to Pago Bay

Table-1a. Hook and line Creel Census Data, summarized by month for fiscal year 1981.

MONTH	Number of Persons	Person- Hours	No. of Gear Units	Gear- Hours	Catch (Kg)
October	NO CENSUS EFFORT				
November	48	123.58	56	150.09	9.73
December	67	226.80	61	209.05	26.0
January	3	13.5	3	13.5	0.31
February	19	31.25	14	16.25	1.71
March	39	69.56	34	63.65	4.03
April	40	98.93	36	89.93	8.76
May	29	46.66	22	35.49	1.52
June	23	17.68	27	22.34	7.61
July	42	68.47	46	74.66	10.6
August	135	263.64	122	252.77	27.24
September	109	484.41	113	508.41	37.15
TOTAL	554	1444.48	534	1436.14	134.66

Table 1b. Hook & Line Data, expanded from Table 1a to yield
Total monthly and annual estimates for FY 1981.

MONTH	Number of Persons	Person- Hours	Gear- Hours	Kg/P-HR	Kg/G-HR	Catch (Kg)
October			NO CENSUS EFFORT			
November	233	948	763	.08	.1	80
December	377	1885	1809	.13	.14	252
January	63	347	347	.02	.02	7
February	181	660	499	.05	.07	33
March	250	656	613	.06	.06	40
April	218	957	905	.1	.12	95
May	123	200	142	.03	.04	6
June	152	259	296	.61	.53	158
July	287	789	864	.18	.16	142
August	482	1539	1311	.21	.25	324
September	627	4567	4675	.1	.1	477
TOTAL	2993	12,807	12,224	.13	.13	1614

Table 2a. Cast net creel census data summarized by month for fiscal year 1981.

MONTH	Number of Persons	Person Hours	No. of Gear Units	Gear Hours	Catch (Kg)
October	NO CENSUS EFFORT				
November	METHOD NOT OBSERVED				
December	METHOD NOT OBSERVED				
January	1	0.25	1	0.25	0
February	7	5.75	6	4.75	0.6
March	15	17.88	11	13.66	5.4
April	35	83.4	32	79.4	37.76
May	57	85.34	40	57.76	15.07
June	30	74.87	18	39.94	6.53
July	17	26.7	10	16.45	4.97
August	43	36.08	28	25.68	9.32
September	28	21.35	19	14.77	8.18
TOTAL	233	351.62	165	252.66	87.83

Table 2b. Cast net data, expanded from Table 2a to yield total monthly & annual estimates for FY 1981.

MONTH	Number of Persons	Person- Hours	Gear- Hours	Kg/P-HR	Kg/G-HR	Catch (Kg)
October		NO CENSUS EFFORT				
November		METHOD	NOT	OBSERVED		
December		METHOD	NOT	OBSERVED		
January	21	26	26	0	0	0
February	66	108	89	.09	.11	10
March	105	214	154	.3	.42	64
April	284	870	786	.42	.47	365
May	280	405	320	.15	.2	62
June	188	807	416	.08	.15	63
July	181	582	293	.14	.28	82
August	387	1019	651	.19	.29	190
September	140	113	77	.48	.7	54
TOTAL	1652	4144	2812	.21	.32	890

Table 3a. Gill net creel census data summarized by month for fiscal year 1981.

MONTH	Number of Persons	Person- Hours	No. of Gear Units	Gear- Hours	Catch (kg)
October	NO CENSUS EFFORT				
November	METHOD NOT OBSERVED				
December	METHOD NOT OBSERVED				
January	3	1.5	3	1.5	0.1
February	2	1.5	2	1.5	0
March	24	45.44	11	23.51	13.9
April	30	37.02	10	11.59	3.84
May	18	45.33	6	14.75	4.79
June	19	12.58	9	5.54	16.58
July	35	38.07	18	30.23	8.58
August	41	54.92	14	20.3	11.01
September	24	*	*	*	*
TOTAL	196	236.36	73	108.92	58.8

* : Unobtainable data

Table 3b. Gill net data, expanded from Table 3a to yield total monthly & annual estimates for FY 1981.

MONTH	Number of Persons	Person- Hours	Gear- Hours	Kg/P-HR	Kg/G-HR	Catch (Kg)
October		NO	CENSUS	EFFORT		
November		METHOD	NOT	OBSERVED		
December		METHOD	NOT	OBSERVED		
January	63	189	189	.07	.07	13
February	28	24	24	0	0	0
March	168	441	194	.31	.7	137
April	243	707	292	.12	.28	83
May	115	289	95	.06	.19	18
June	125	187	98	1.54	2.95	289
July	347	1327	856	.24	0.37	318
August	207	695	245	.36	1.03	253
September	90	0	0	0	0	0
TOTAL	1386	3859	1993	.29	0.56	1111

Table 4a. Surround net creel census data, summarized by month for fiscal year 1981.

MONTH	Number of Persons	Person- Hours	No. of Gear Units	Gear- Hours	Catch (Kg)
October		NO CENSUS	EFFORT		
November	4	20	1	5	7.6
December	11	35.75	1	3.25	20
January		METHOD NOT OBSERVED			
February	17	49.54	2	2.67	37.08
March	30	137	3	12.25	94.81
April	7	38.5	1	5.5	5.5
May	15	49.15	3	9.83	12.4
June	24	104.5	4	15	45.65
July	16	68.5	2	8.5	1.12
August	5	5	1	1	0.43
September	19	*	*	*	*
TOTAL	148	507.94	20	63	224.59

* : Unobtainable data

Table 4b. Surround net data, expanded from Table 4a to yield total monthly & annual estimates for FY 1981.

MONTH	Number of Persons	Person- Hours	Gear- Hours	Kg/P-HR	Kg/G-HR	Catch (Kg)
October		NO CENSUS	EFFORT			
November	52	260	130	0.38	.76	99
December	110	660	60	.56	6.16	370
January		METHOD	NOT OBSERVED			
February	203	1184	149	.66	5.24	778
March	388	1898	189	.73	7.38	1391
April	63	347	50	1.54	10.78	534
May	165	715	108	.25	1.65	179
June	240	1215	263	0.68	3.14	824
July	72	493	61	.02	.16	10
August	105	105	21	.09	.45	9
September	86	0	0	0	0	0
TOTAL	1484	6877	1031	.61	4.07	4194

Table 5a. Spearfishing creel census data summarized by month
for fiscal year 1981.

MONTH	Number of Persons	Person- Hours	No. of Gear Units	Gear- Hours	Catch (Kg)
October	NO CENSUS	EFFORT			
November	METHOD	NOT OBSERVED			
December	METHOD	NOT OBSERVED			
January	3	3	3	3	4.03
February	5	8	5	8	1.32
March	1	0.5	1	0.5	0
April	7	52.5	2	15	4.23
May	7	17.1	7	17.1	3.87
June	16	27.89	7	10.26	9.7
July	4	*	*	*	*
August	21	44.92	18	37.64	7.61
September	5	*	*	*	*
TOTAL	69	153.91	43	91.5	30.76

* : Unobtainable data

Table 5b. Spearfishing data, expanded from Table 5a to yield total monthly & annual estimates for FY 1981.

MONTH	Number of Persons	Person- Hours	Gear- Hours	Kg/P-HR	Kg/G-HR	Catch (Kg)
October		NO	CENSUS	EFFORT		
November		METHOD	NOT	OBSERVED		
December		METHOD	NOT	OBSERVED		
January	63	126	126	1.34	1.34	169
February	48	105	105	.17	.17	18
March	21	11	11	0	0	0
April	63	473	135	.08	.28	38
May	26	134	134	.23	.23	31
June	171	283	133	.15	.32	43
July	75	0	0	0	0	0
August	525	138	117	.17	.2	23
September	69	0	0	0	0	0
TOTAL	1061	1270	761	.25	.42	322

Table 6. Summary of Catch and Effort, by Method, for Fiscal year 1981.

METHOD	Person- Hours	%	Gear- Hours	%	Kg/P-HR	Kg/G-HR	Catch (Kg)	%
Hook and Line	12,807	44.2	12,224	65.0	0.13	.13	1614	19.8
Cast Net	4144	14.3	2812	14.9	0.21	.32	890	10.9
Surround Net	6877	23.8	1031	5.5	0.61	407	4194	51.6
Gill Net	3859	13.3	1993	10.6	0.29	.56	1111	13.7
Spearfishing	1270	4.4	761	4	0.25	.42	322	4
TOTAL	28,957	100	18,821	100	0.28	0.43	8131	100

Table 7. Monthly Creel Census inshore effort for FY 1981 and total No. of holidays, Weekends & Weekdays used in expanding actual data to derive estimates. G-A = Gun to Adelup, A-A = Adelup to Agat, P-M = Pago to Merizo.

MONTH	No. of Holidays & Weekends	No. of Weekdays	No. of Hol. & Wkends Censused G-A	No. of Hol. & Wkends Censused A-A	No. of Hol. & Wkends Censused P-M	No. of Weekdays Censused G-A	No. of Weekdays Censused A-A	No. of Weekdays Censused P-M	Total No. of days Censused
October	9	22	0	0	0	0	0	0	0
November	13	17	2	1	0	0	0	1	4
December	10	21	0	0	2	1	0	0	3
January	10	21	0	0	0	0	0	1	1
February	9	19	0	0	1	1	0	2	4
March	10	21	1	1	2	1	1	0	6
April	9	21	1	1	1	1	1	1	6
May	11	20	1	1	1	1	0	1	5
June	9	21	1	1	1	1	0	1	5
July	9	22	1	1	0	1	0	1	4
August	10	21	1	2	2	0	0	2	7
September	9	21	1	1	2	1	1	0	6

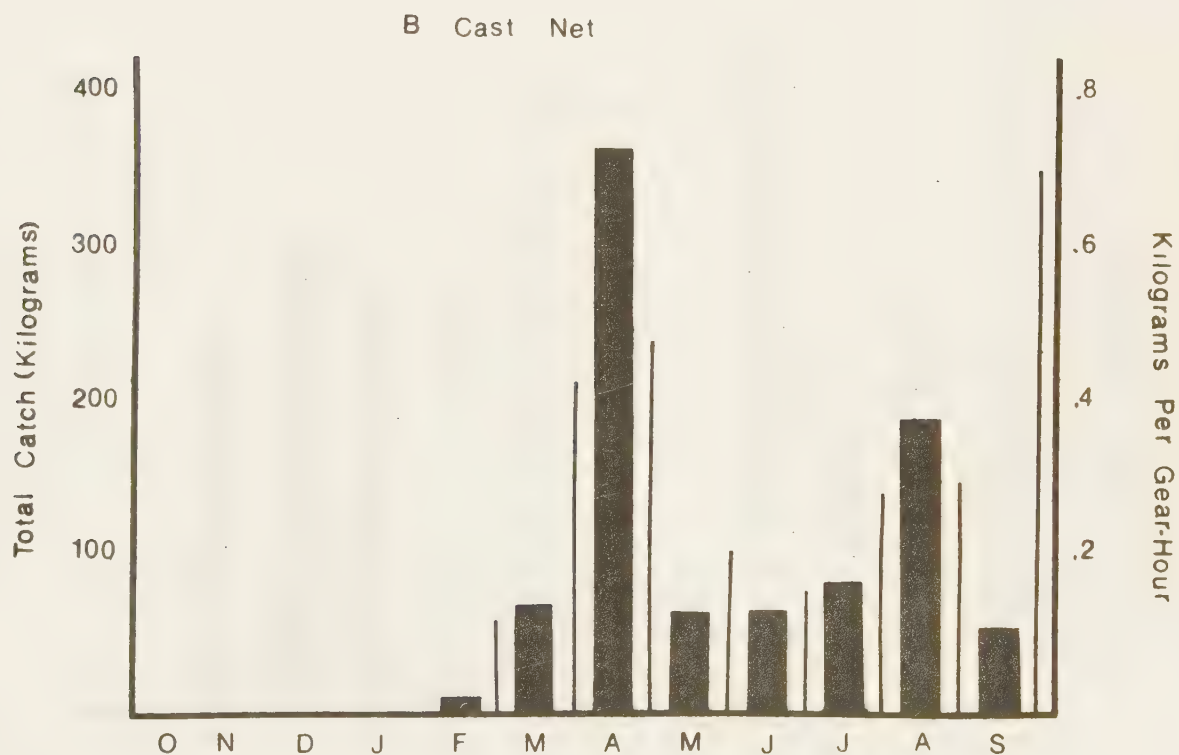
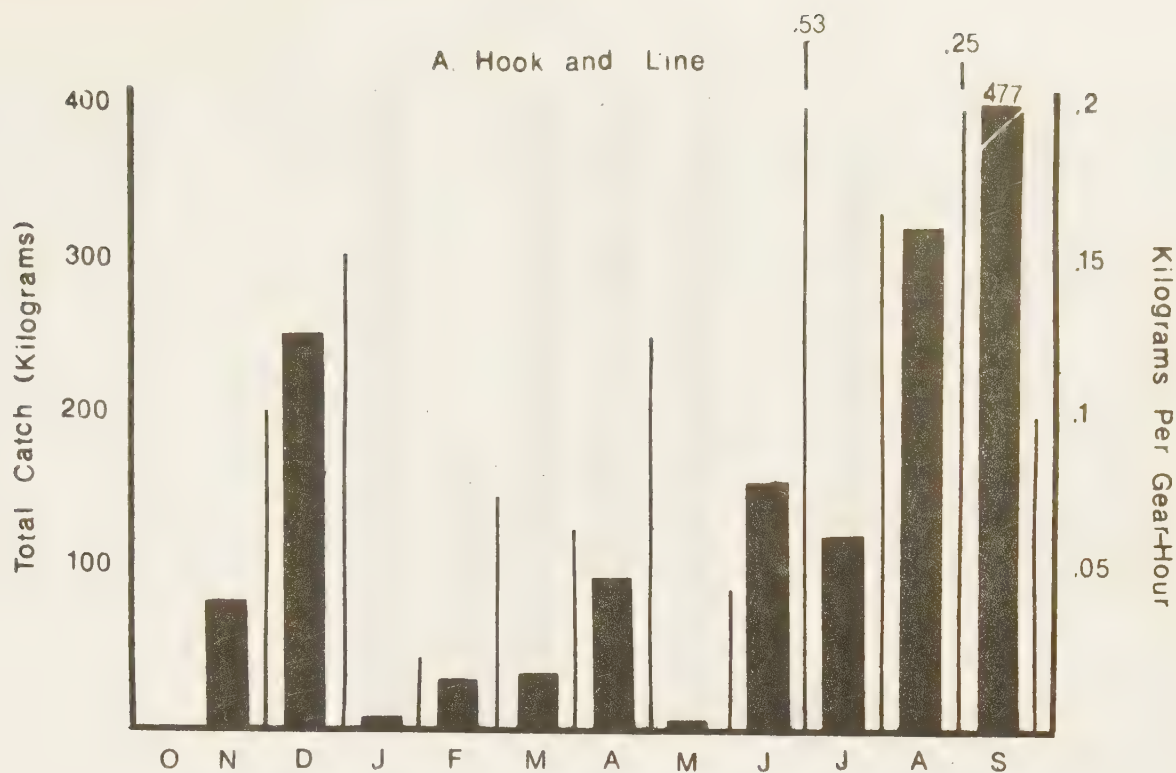


Figure 2. Monthly Total Catch (Kg) and Catch Rate (kg/Gear-Hour) for the Major Inshore Fishing Methods and for All Five Methods Combined.

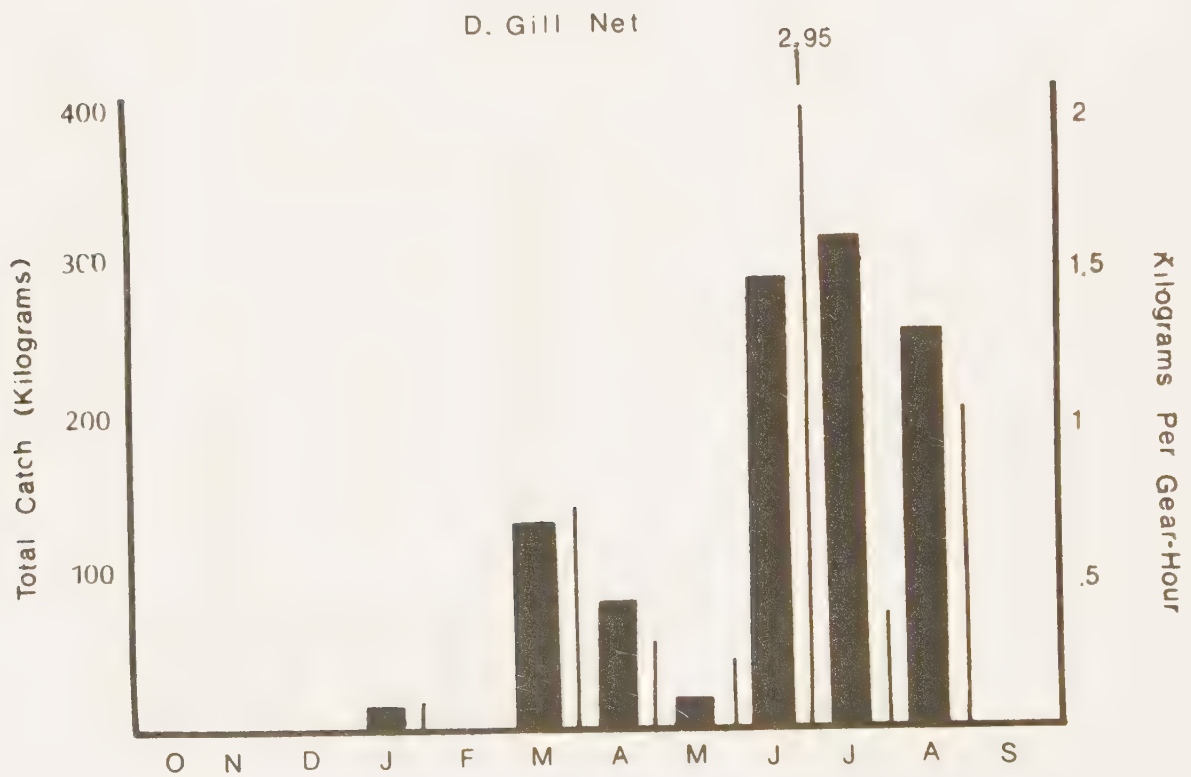
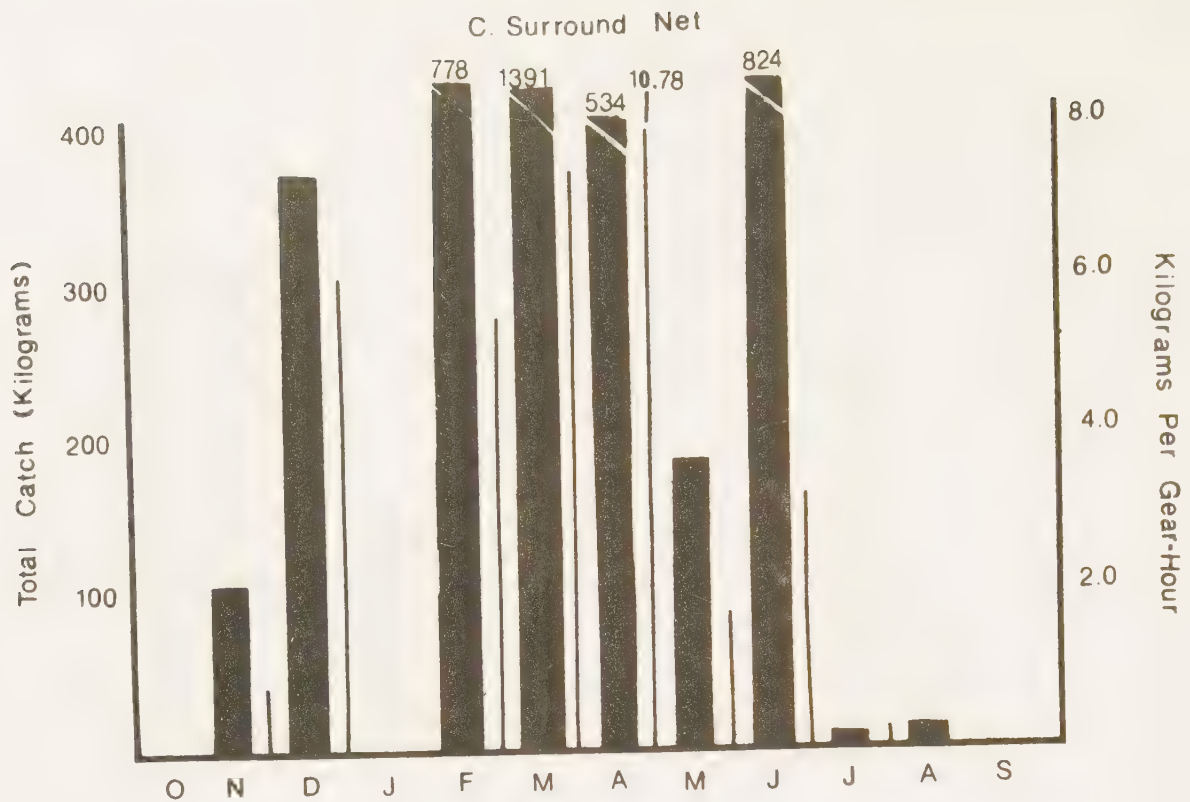
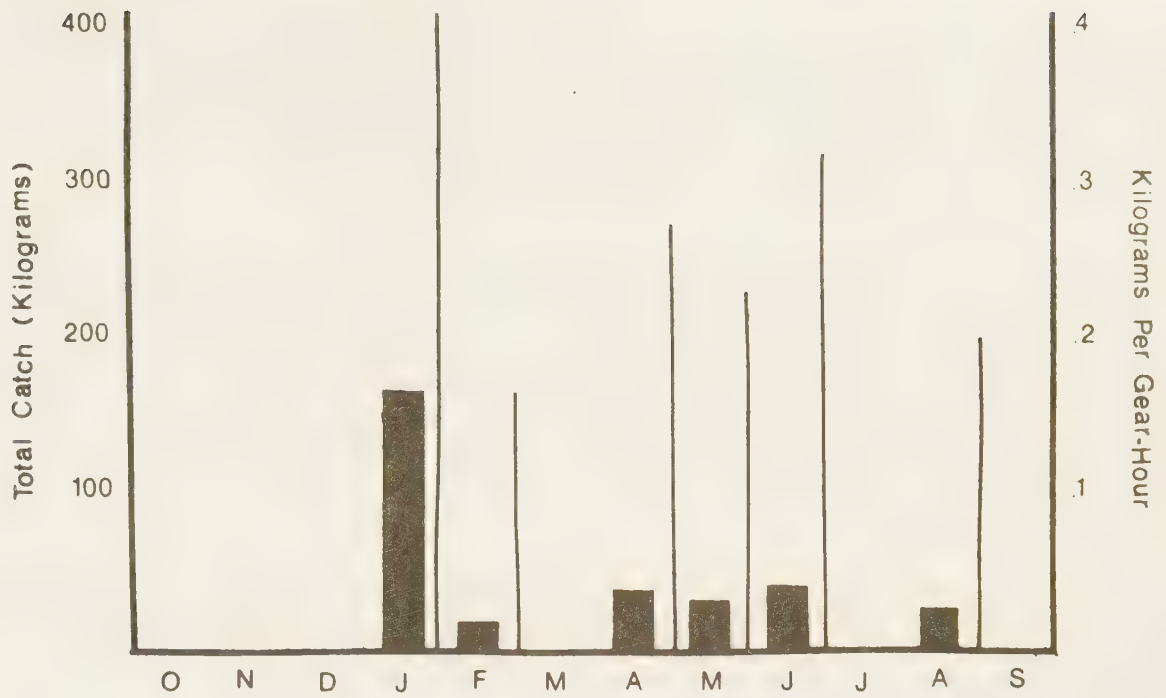


Figure 2. Continued

E. Spearfishing



F. Total

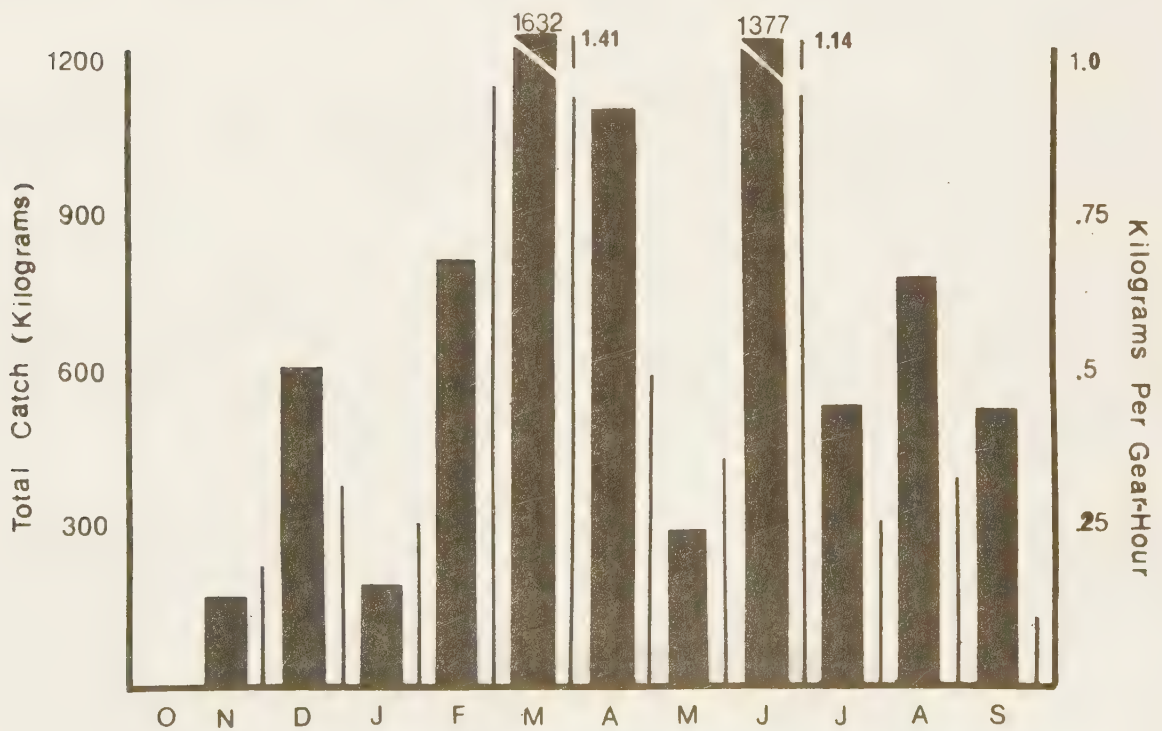


Figure 2. Continued

There was an apparent decline in effort expended by anglers in gill netting this fiscal year. Approximately 13% of the total person-hours and 10% of the total gear-hours was devoted to this method, approximately one-half the effort of FY80. Approximately 13% of the total yearly catch, (1111 kg) was caught. Like cast netting, gill netting displayed seasonal differences, with the highest effort occurring during the summer months.

The effort expended in surround netting was 23.8% in total person-hours and 5.5% in total gear-hours. This method yielded over 51% of the total yearly catch, the highest catch of all methods. Correspondingly, CPUE values (0.61 kg per person-hour and 4.07 kg per gear-hour) were much higher for this method than those of other methods. The relatively high CPUE values reflect unusually high catches during spring and summer months. There were a few instances of atulai caught with surround netting, however, due to the long hours expended for this method, complete data as to actual catch and fishing time were unobtainable.

Spearfishing is the most physically demanding method of inshore fishing. The effort expended in spearfishing was approximately 4.0% of the total fishing effort. This resulted in 4.0% of the total yearly catch. CPUE values, however, were second to that of surround netting, with 0.25 kg of fish caught each person-hour and 0.42 kg per gear-hour.

In addition, ninety persons were censused while collecting 27.7 kg of octopi from the reef flats during 175 person-hours and 156 gear-hours of fishing effort. From this data it was estimated that 2131 person-hours of harvesting yielded 433 kg of octopi during FY 1981. This results in a CPUE value of 0.2 kg per person-hour.

Ninety-five persons were interviewed while harvesting shellfish, primarily the clam, Grafrarium tumidum and topshell Trochus niloticus. These people harvested 65.19 kg in 114 hours, yielding total FY 1981 estimates of 961 kg harvested by 781 persons in 1366 hours (CPUE of 0.7 kg/P-HR).

The seasonal harvest of juvenile rabbitfish (Siganidae) frequently represents a significant portion of the total annual harvest of reef fish. For this reason, separate estimates for these fish are made. These "manahac" runs are anticipated by fishermen and participation in this event is high. Cast nets and surround nets are the preferred gear. The total estimated manahac harvest for 1981 was 4,158 Kg, and the highest since 1977 when 4,500 Kg of manahac were censused.

Large numbers of manahac leso (Siganus spinus) and manahac hatang (Siganus argenteus) first appeared on selected leeward reefs on April 25, two days prior to the last quarter moon. This run continued for approximately five days and according to DAWR estimates, totaled approximately 2,040 Kg. As in previous years, the heaviest concentrations of manahac were in Tumon Bay, Agana Bay and Cocos Lagoon. A second and smaller run occurred on May 25 and 26 in Bile Bay. Approximately 318 Kg of manahac leso were harvested. Between June 23 and 25, about 1800 Kg of manahac leso and manahac hatang were harvested in Cocos Lagoon, Togcha Reef, Ajayan Channel and Piti Channel.

RECOMMENDATIONS

Guam is currently participating in a regionwide program of reviewing and analyzing past creel census data for incorporation into the Fisheries Information Network (FIN). Modifications based upon these analyses should be incorporated into the existing data collection program.

Report prepared by: Christine C. Palomo

PROJECT TITLE: FISH WEIR REPORT

PERIOD COVERED: October 1, 1980 to September 30, 1981

A total catch of 3024.4 kg of fish was recorded in 39 catch reports submitted by the six fish weir operators permitted in FY 81. One operator did not return any reports contributing to this years general decline in cooperation. A full 46% of the required reports were not submitted. It was necessary therefore to expand on the recorded data to calculate an estimated annual harvest from all the fish weirs. This was done using the following formula:

$$(Cr/Rm) 12 (6) - (Cr/Rm) 12 (6) 0.1 = Ce$$

where Cr is the total reported catch in Kg; Rm is the number of monthly reports submitted by the weir operators during the year; 12 is the number of months in a year; 6 is the number of weir sites in operation; and, 0.1 is a correction factor for down time.

The actual and estimated catch is presented in Table 1. As usual, there is variability between years in the ranking by percent of catch between the major component species. This year, jacks (Carangidae, 23.1%, primarily Caranx melampygus) was the dominant family of fish caught, followed by snappers (Lutjanidae, 17.0%), goatfish (Mullidae, 7.8%) and mullets (Mugilidae, 7.3%). The resultant total estimated annual harvest (5,036 Kg) decreased from FY 80 (8,413 Kg) and FY 79 (6,296 Kg).

An accurate estimate of the annual fish weir harvest can only be based upon fairly complete and conscientiously kept monthly catch reports. Because this years returns were so poor, each fish weir applicant is now required to sign an agreement in addition to the regular application. This agreement states the operator will submit his catch reports by the 15th of each month or his permit will be revoked on the 16th and his weir site "retired".

Report prepared by: R. Logan Kock

Table 1. Reported and estimated fish weir harvest for FY 81. The reported catch is from 39 monthly reports submitted by 5 of the weir operators.

Fish Family	Reported catch (Kg)	Percent (%) of Total catch	Estimated Harvest (Kg)
Acanthuridae (Surgeon fishes)	68.6	2.3	114.2
Carangidae * (Jacks)	697.5	23.1	1161.3
Carangidae <u>S. crumenophthalmus</u> (Atulai)	109.5	3.6	182.3
Leiognathidae (Soapys)	205.5	6.8	342.2
Lutjanidae (Snappers)	513.0	17.0	854.2
Mugilidae (Mulletts)	221.8	7.3	369.3
Mullidae (Goat fishes)	235.9	7.8	392.8
Serranidae (Groupers)	27.7	1.0	46.1
Siganidae (Rabbit fishes)	145.1	4.8	241.6
Others	799.8	26.4	1331.7
Total (12 mo.)	3024.4	100	5035.7

* excluding Selar crumenophthalmus

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-18
SUB-PROJECT NO.: F
STUDY NO.: F-1
JOB NO.: 5

JOB TITLE: Reef fish population investigations through the use of permanent transects

PERIOD COVERED: October 1, 1980 - September 31, 1981

SUMMARY

A total of 112 data collecting dives was made during 14 months of a 15-month time span. These dives resulted in the recording of 436, 50 m transect counts of fish species seen at four depths on the reef front at two locations on Guam. Preliminary analysis shows fish abundance to peak from March to July at all depths at both locations. A less distinct peak appears to occur during the fall from October to December. These fluctuations may be the result of increased spawning (fall) and recruitment (spring) activities which probably occur in response to changes in local current patterns that are related to seasonal wind shifts.

BACKGROUND

Relatively little is known of the ecology of coral reef fishes. In reviews of the subject Ehrlich (1975) and Goldman and Talbot (1976) noted the difficulty inherent in the study of these animals. The compilation of reliable quantitative field data may become difficult and time consuming. Consequently, there have been relatively few detailed studies made on coral reef fish populations, especially for time spans longer than one year. The need for such studies was mentioned by Ehrlich (1975), and clearly demonstrated in a more recent review by Sale (1980).

During FY 1978 and FY 1979, Aquatic and Wildlife Resources evaluated the use of a steel barge artificial reef as a way of increasing the available fish habitat on Guam. The resident coral reef fish community was monitored for 20-months. Visual counts of fish were made on the barge itself and along line transects permanently placed over large surrounding areas of natural reef. A by-product of that project was the documentation of cyclical-seasonal changes in the overall abundance of fishes occurring on the natural reef areas (Kock, 1979). The present study was undertaken to monitor these fluctuations in a more comprehensive and detailed fashion.

OBJECTIVE

The primary objective of this study is to investigate the existence of seasonal variability within the reef front fish community of Guam. Hopefully, this study

will result in the verification of seasonal changes in the abundance, species richness, species composition, and/or distribution of certain coral reef fishes across different depths within each study site.

PROCEDURE

During the spring of 1979, study sites on the leeward (western) side of Guam were established at Asan Pt. and Ipao Pt. (Figure 1). At each site duplicate 50 m transects were placed along approximate depth contours of 4.6, 9.1, 18.3 and 30.5 m (15, 30, 60, and 100 ft, respectively). A transect consisted of six unconnected rebar stakes, each about 38 cm (15 in) in length, embedded into reef rock at 10 m intervals. Each stake was flagged with a small piece of plastic surveyor's marking tape to aid in its location on subsequent field days.

From June through August 1979, preliminary dives were made at the study sites in order to prepare the biologist for the data collection phase of the project. During that time the biologist became familiar with the locations of the transects and the individual stakes, as well as with the conspicuous fish species commonly found there. This time period also afforded the biologist a chance to become skilled in the use of the submersible micro-cassette tape deck upon which the population data for this study were to be recorded.

Beginning in September 1979, formal monthly fish counts were conducted on the permanent transects at both study sites. Four to six field days per month were required to maintain the transects and to do the fish counts. Data collection was terminated after the November 1980 censuses since a full seasonal cycle had elapsed over the 15-month period.

Field data collection was limited to the time between 1000 and 1400 hours. Counts of individuals were made for fish species observed within two vertical meters of the substrate and one meter either side of the biologist as he swam from stake to stake on each transect. Dives were limited to a maximum of two depths per day, normally paired as 30.5 and 4.6 m, and 18.3 and 9.1 m.

On a single field day both 50 m transects at each of the two depths were censused twice (down & back). There were exceptions, however, when during the last three months of data collection the deepest transects were censused only once per day (one direction only). This was due primarily to the failure of the recording system in September 1980. Since the unit could not be repaired or replaced in time to be used during the rest of the data collection phase, it was necessary to record the remaining counts by hand. This proved to be a problem only for the deepest transects because of the relatively short no-decompression time limit (25 min) for dives to that depth. Because it took the biologist longer to write down his observations than it did for him to speak them, there was sufficient bottom time to record the data for only one pass along these transects. The recording system did fail one other time in January 1980, resulting in the loss of that month's counts.

RESULTS AND DISCUSSION

A total of 112 data collecting dives was made during this study. These dives resulted in the recording of 436, 50 m transect counts. Of this total 352 counts were recorded on tape and 84 counts were hand compiled on underwater paper. All



Figure 1. Map of Guam showing the locations of the study sites.

data have been transcribed onto paper to facilitate computer analysis. Currently, the data are being coded for testing. Total counts of individuals and species, as well as the counts for the 25 most abundant species found at each depth at each study site will be subjected to the first phase of computer testing. The results of these tests will be presented in our next annual report. However, some preliminary results are presented here.

Tables 1 and 2 list the fish species encountered on the transects during the study. Altogether, representatives of 33 families were seen, with 25 (76%) of these families having been recorded at both locations. Of the 198 species that were recorded on all of the transects, 131 (66%) were seen at both sites. More species were present in the Ipao counts (176) than in the Asan counts (153). In addition, 45 species were observed only on the Ipao transects while 22 species were encountered only on the Asan transects. At both study sites more species were counted on the transects at 18.3 m (60 ft) than on any of the others.

Figures 2 through 5 illustrate the overall fish abundance fluctuations found at both study sites. Each monthly total equals the sum of all four transect counts made at a particular depth, except those for the last three months at 30.5 m (100 ft). For these the actual total was doubled before being graphed. This was done in order to make the densities comparable across all months and depths. Therefore, the numbers indicated represent the numbers of fish counted per 400 m² of transect area.

The data indicate a general increase in overall fish density at all depths during the spring and summer months, with maximums occurring between March and July. Another less distinctive increase appears to occur during the fall months of October through December. These changes, which were observed at both study sites, may indirectly support the conclusions of several others (Russell, Talbot and Domm, 1974; Johannes, 1978; Molles, 1978; Talbot, Russell and Anderson, 1979; Williams and Sale, 1981) that spawning and recruitment of reef fish are seasonal behaviors for tropical as well as temperate species. During periods of increased spawning and recruitment both the numbers of species, and of individuals within species, have been found to increase noticeably.

Johannes (1978) based his conclusions on observations from 18 tropical locations in the Indian Ocean, Pacific Ocean (North and South) and Caribbean Sea. Among 15 of these locations collective spawning peaks are experienced in the spring; while in at least 5 of them second peaks occur in the fall. Although Guam is not listed among these locations, the peaks for 8 other Micronesian sites which are listed occur from February to June. Of these locations, Yap is the geographically nearest to Guam and its peak occurs March to June. In seeking to explain the apparent timing of spawning and recruitment, Johannes concluded that seasonally reduced wind and/or current velocities are most likely to be of a major influence.

Unfortunately, adequate data on the monthly ocean current patterns near Guam were not available for use in this report. However, the Naval Oceanography Command Detachment (NODC), U.S. Naval Air Station, Guam was able to furnish data on the monthly mean wind velocities for the island. These velocities, shown in Fig. 6, are based on a total of 64,150 hourly observations taken from 1949-1970. Also shown are the monthly percent frequencies of offshore wind for the approximate locations of the Ipao and Asan study sites. These frequencies are also based on NODC observations made over the same 20-year period.

It is apparent from Fig. 6 that the area around Guam experiences spring and fall shifts in wind velocity and direction. These shifts are associated with the annual tradewind season. If local ocean currents are influenced by the wind, one

Table 1. Fish species seen on Ipao Pt. transects from September 1979 through November 1980; * = seen only on Ipao Pt. transects.

FAMILY/SPECIES	DEPTH			
	15'	30'	60'	100'
ACANTHURIDAE (Surgeonfishes)				
Acanthurus glaucoparietus Cuvier	X	X	X	X
A. lineatus (Linnaeus)	X	X		
A. mata (Cuvier)		X		
A. nigrofusus (Forsskal)	X	X	X	X
A. olivaceus Bloch & Schneider			X	
A. pyroferus Kittlitz	X	X	X	X
A. triostegus (Linnaeus)	X			
*Ctenochaetus binotatus Randall			X	
C. striatus (Quoy & Gaimard)	X	X	X	X
*Naso annulatus (Quoy & Gaimard)		X		
N. brevirostris (Valenciennes)	X	X	X	X
N. hexacanthus (Bleeker)				X
N. lituratus (Bloch & Schneider)	X	X	X	X
*N. unicornis (Forsskal)	X	X	X	X
*N. vlamingi (Valenciennes)				X
Zebrasoma flavescens (Bennett)			X	X
*Z. scopas (Cuvier)			X	X
Z. velliiferum (Bloch)			X	X
APOGONIDAE (Cardinalfishes)				
*Apogon sp.				X
Cheilodipterus quinquelineatus (Cuvier)		X		
*C. macrodon (Lacepede)			X	X
AULOSTOMIDAE (Trumpetfishes)				
Aulostomus chinensis (Linnaeus)	X	X	X	X
BALISTIDAE (Triggerfishes)				
Balistipus undulatus (Park)	X	X	X	X
Balistoides conspicillum (Bloch & Schneider)			X	
Melichthys vidua (Solander)	X	X	X	X
Pseudobalistes flavomarginatus (Ruppell)	X			
*Rhinecanthus aculeatus (Linnaeus)				X
Sufflamen bursa (Bloch & Schneider)	X	X	X	X
S. chrysopterus (Bloch & Schneider)	X	X	X	X
BLENNIIDAE (Blennies)				
Aspidontis taeniatus (Quoy & Gaimard)		X		
Escenius bicolor (Day)		X	X	
*Exallias brevis (Kner)	X	X		
Meicanthus atrodorsalis (Gunther)	X	X	X	X
Plagiotremus tapeinosoma (Bleeker)	X	X		
*Blenniid sp. 1	X			
CAESIONIDAE (Fusiliers)				
*Pterocaesio chrysozonus (Cuvier)			X	X

FAMILY/SPECIES	DEPTH			
	15'	30'	60'	100'
CHAETODONTIDAE (Butterflyfishes)				
Chaetodon auriga Forsskal	X	X	X	X
*C. bennetti Cuvier				X
C. citrinellus Cuvier	X	X	X	X
C. ephippium Cuvier	X	X	X	X
*C. kleini Bloch			X	
*C. lineolatus Cuvier		X	X	
C. lunula Lacepede	X	X	X	
C. mertensii Cuvier			X	X
C. ornatissimus Cuvier	X	X	X	
C. punctatofasciatus Cuvier		X	X	X
*C. quadrimaculatus Gray	X	X		
C. reticulatus Cuvier	X	X	X	X
C. trifasciatus Park	X	X	X	X
C. ulietensis Cuvier		X	X	X
C. unimaculatus Bloch	X	X		X
*C. vagabundus Linnaeus				X
Forcipiger flavissimus Jordan & McGregor	X	X	X	X
F. longirostris (Broussonet)				X
Hemitaurichthys polylepis (Bleeker)			X	
Heniochus chrysostomus Cuvier		X	X	X
Megaprotodon trifascialis (Quoy & Gaimard)	X	X	X	X
CIRRHITIDAE (Hawkfishes)				
Cirrhitichthys falco Randall		X	X	
Neocirrhites armatus Castelnau	X	X	X	
Paracirrhites arcatus (Cuvier)	X	X	X	
P. forsteri (Bloch & Schneider)	X	X	X	
FISTULARIIDAE (Coronetfishes)				
*Fistularia commersonii Ruppell		X		
GOBIIDAE (Gobies)				
Nemateleotris magnifica Fowler		X	X	X
Pogonoculius zebra Fowler	X	X		
Ptereleotris evides (Jordan & Hubbs)	X	X	X	
Valenciennea strigatus (Broussonet)	X	X		
HOLOCENTRIDAE (Squirrelfishes)				
Adioryx caudimaculatus (Ruppell)		X	X	X
*A. spinnifer (Forsskal)	X	X	X	
Flammeo sammara (Forsskal)			X	
*Myrpristis sp.	X		X	X
KYPHOSIDAE (Rudderfishes)				
*Kyphosus cinerascens (Forsskal)			X	
LABRIDAE (Wrasses)				
Anampses caeruleopunctatus Ruppell	X	X	X	X
A. meleagrides Valenciennes	X			
A. twisti (Bleeker)	X	X	X	X

DEPTH

FAMILY/SPECIES	15'	30'	60'	100'
Bodianus axillaris (Bennett)	X	X	X	X
Cheilinus chlorourus (Bloch)	X	X	X	X
C. fasciatus (Bloch)	X			X
C. rhodocrous Gunther	X	X	X	X
C. trilobatus Lacepede	X	X	X	X
C. undulatus Ruppell				X
*Cheilio inermis (Forsskal)	X			
Cirrhilabrus katherinae Shepard & Randall	X	X	X	X
Coris gaimard (Quoy & Gaimard)		X	X	X
Epibulus insidiator (Pallas)	X	X	X	X
Gomphosus varius Lacepede	X	X	X	
Halichoeres biocellatus Schultz	X		X	X
H. hortulanus (Lacepede)	X	X	X	X
H. margaritaceus (Valenciennes)	X	X		
H. marginatus Ruppell	X	X	X	X
H. sp. 1		X	X	
Hemigymnus melapterus (Bloch)	X		X	
Hologymnosus doliatus (Lacepede)			X	
Labroides bicolor Fowler & Bean	X	X	X	
L. dimidiatus (Valenciennes)	X	X	X	X
Labropsis micronesica Randall			X	
L. xanthonotus Randall	X	X	X	
Macropharyngodon meleagris (Valenciennes)	X	X	X	
Pseudocheilinus evanidus Jordan & Everman			X	X
P. hexataenia (Bleeker)		X	X	X
Stethojulis bandanensis (Bleeker)	X	X	X	
Thalassoma amblycephalum (Bleeker)	X	X		
*T. fuscum (Lacepede)		X		
T. lutescens (Lay & Bennett)	X	X	X	
T. quinquevittatum (Lay & Bennett)	X	X	X	
*Labrid sp. 1		X		
*Labrid sp. 2				X
*Labrid sp. 3		X		
LETHRINIDAE (Emperors)				
*Gnathodentex aureolineatus (Lacepede)	X		X	
*Lethrinus semicinctus Valenciennes			X	
LUTJANIDAE (Snappers)				
*Lutjanus fulvus (Bloch & Schneider)		X		
*L. sp.				X
*Macolor niger (Forsskal)		X		
MONACANTHIDAE (Filefishes)				
*Amanses scopas (Cuvier)	X	X		
Cantherhines pardalis (Ruppell)	X	X		
*Oxymonacanthus longirostris (Bloch & Schneider)	X	X	X	X
Paraluteres prionurus Bleeker		X		
Pervagor melanocephalus (Bleeker)	X	X	X	X
MUGILOIDIDAE (Sand perches)				
Parapercis clathrata Ogilby	X	X	X	X

FAMILY/SPECIES	DEPTH			
	15'	30'	60'	100'
MULLIDAE (Goatfishes)				
Mulloidichthys flavolineatus (Lacepede)	X		X	X
*Parupeneus barberinus (Lacepede)				X
P. bifasciatus (Lacepede)	X	X	X	X
P. chryseredros (Lacepede)	X	X	X	X
P. pleurostigma (Bennett)		X		X
P. trifasciatus (Lacepede)	X	X	X	X
MURAENIDAE				
*Gymnothorax sp.				X
OSTRACIONTIDAE (Boxfishes, Cowfishes)				
*Ostracion cubicus Linnaeus	X	X		
O. meleagris Shaw	X	X	X	X
PEMPHERIDAE (Sweepers)				
*Pempheris oualensis Cuvier		X	X	X
POMACANTHIDAE (Angelfishes)				
Apolemichthys trimaculatus (Cuvier)		X		
Centropyge flavissimus (Cuvier)	X	X	X	X
C. heraldi Woods & Schultz	X		X	X
C. shepardi Randall & Yasuda		X	X	X
*Pomacanthus imperator (Bloch)	X			
Pygoplites diacanthus (Boddaert)	X	X	X	X
POMACENTRIDAE (Damselfishes)				
Amphiprion clarkii (Bennett)	X	X	X	
Chromis acares Randall & Swardloff	X	X		
*C. agilis Smith			X	X
C. amboinensis (Bleeker)			X	X
C. margaritifer Fowler	X	X		
Chrysiptera traceyi (Woods & Schultz)	X	X	X	X
*Dascyllus aruanus (Linnaeus)	X			
D. reticulatus (Richardson)	X	X	X	X
D. trimaculatus (Ruppell)			X	X
Plectroglyphidodon dickii (Lienard)	X	X		
P. johnstonianus Fowler & Ball	X	X	X	
P. lacrymatus (Quoy & Gaimard)	X		X	
Pomacentrus amboinensis Bleeker	X	X	X	
P. vaiuli Jordan & Seale	X	X	X	X
Pomachromis guamensis Allen & Larson	X	X		
Stegastes fasciolatus (Ogilby)	X	X		
SCARIDAE (Parrotfishes)				
*Calotomus sandwichensis (Valenciennes)			X	
Cetoscarus bicolor (Ruppell)	X	X	X	
*Hipposcarus longiceps (Valenciennes)			X	
Scarus brevifilis (Gunther)	X	X	X	X
S. ghobban Forsskal	X	X	X	
S. gibbus (Ruppell)	X		X	

FAMILY/SPECIES	DEPTH			
	15'	30'	60'	100'
<i>S. psittacus</i> Forsskal	X	X	X	X
<i>S. rubrioviolaceus</i> (Bleeker)	X	X	X	
<i>S. schlegeli</i> (Bleeker)	X	X	X	X
<i>S. sordidus</i> Forsskal	X	X	X	X
* <i>S. tricolor</i> Bleeker				X
*Scarid sp. 1				
SERRANIDAE (Groupers)				
<i>Cephalopholis urodelus</i> (Bloch & Schneider)	X	X	X	X
<i>Epinephelus fasciatus</i> (Forsskal)		X		X
* <i>E. merra</i> Bloch				X
<i>Variola louti</i> (Forsskal)				
SIGANIDAE (Rabbitfishes)				
<i>Siganus argenteus</i> (Quoy & Gaimard)			X	X
SYNODONTIDAE (Lizardfishes)				
* <i>Synodus gracilis</i> (Quoy & Gaimard)				X
<i>S. variegatus</i> (Lacepede)		X	X	X
TETRAODONTIDAE (Smooth puffers)				
<i>Arothron nigropunctatus</i> (Bloch & Schneider)			X	X
<i>Canthigaster bennetti</i> (Bleeker)		X	X	
<i>C. coronata</i> (Valliant & Sauvage)				X
<i>C. janthinoptera</i> (Bleeker)	X	X		
<i>C. solandri</i> (Richardson)	X	X	X	X
<i>C. valentini</i> (Bleeker)	X	X	X	
ZANCLIDAE (Moorish idols)				
<i>Zanclus cornutus</i> (Linnaeus)	X	X	X	X
Total No. Families	21	23	26	25
Total No. Species	107	118	119	98

Table 2. Fish species seen on Asan Pt. transects from September 1979 through November 1980; * = seen only on Asan Pt. transects.

FAMILY/SPECIES	DEPTH			
	15'	30'	60'	100'
ACANTHURIDAE (Surgeonfishes)				
Acanthurus glaucopariens Cuvier	X	X	X	X
A. lineatus (Linnaeus)	X			
A. mata (Cuvier)	X	X	X	
A. nigrofasciatus (Forsskal)	X	X	X	X
A. olivaceus Bloch & Schneider		X	X	X
A. pyroferus Kittlitz			X	X
A. triostegus (Linnaeus)	X	X		
Ctenochaetus striatus (Quoy & Gaimard)	X	X	X	
Naso brevirostris (Valenciennes)			X	X
N. hexacanthus (Bleeker)				X
N. lituratus (Bloch & Schneider)	X	X	X	X
*Paracanthurus hepatus (Linnaeus)		X	X	
Zebrasoma flavescens (Bennett)		X	X	X
Z. veliferum (Bloch)			X	
APOGONIDAE (Cardinalfishes)				
*Apogon novemfasciatus Cuvier			X	
Cheilodactylus quinquelineatus (Cuvier)				X
AULOSTOMIDAE (Trumpetfishes)				
Aulostomus chinensis (Linnaeus)	X			X
BALISTIDAE (Triggerfishes)				
Balistapus undulatus (Park)		X	X	X
Balistoides conspicillum (Bloch & Schneider)	X		X	X
*B. viridescens (Bloch & Schneider)			X	X
Melichthys vidua (Solander)	X	X	X	X
*Odonus niger (Ruppell)			X	
Pseudobalistes flavomarginatus (Ruppell)			X	
*Rhinecanthus echarpe (Lacepede)	X			
Sufflamen bursa (Bloch & Schneider)	X	X	X	X
S. chrysopterus (Bloch & Schneider)	X	X	X	
BLENNIIDAE (Blennies)				
Aspidontis taeniatus (Quoy & Gaimard)		X		
Escenius bicolor (Day)	X	X	X	
Meicanthus atrodorsalis (Gunther)	X		X	X
Plagiotremus tapeinosoma (Bleeker)	X	X	X	
CARACANTHIDAE (Velvetfishes)				
*Caracanthus maculatus (Gray)		X		
CARANGIDAE (Jacks, Pompanos)				
*Caranx melampygus Cuvier		X		
CHAETODONTIDAE (Butterflyfishes)				
Chaetodon auriga Forsskal	X			

FAMILY/SPECIES	DEPTH			
	15'	30'	60'	100'
<i>C. citrinellis</i> Cuvier	X	X	X	
<i>C. ephippium</i> Cuvier		X		X
<i>C. lunula</i> (Lacepede)	X			X
<i>C. mertensii</i> Cuvier			X	X
<i>C. ornatissimus</i> Cuvier	X			
<i>C. punctatofasciatus</i> Cuvier	X	X	X	X
<i>C. reticulatus</i> Cuvier	X	X	X	
<i>C. trifasciatus</i> Park		X		X
<i>C. ulietensis</i> Cuvier			X	
<i>C. unimaculatus</i> Bloch		X		X
<i>Forcipiger flavissimus</i> Jordan & McGregor	X	X		X
<i>F. longirostris</i> (Broussonet)				X
<i>Hemitaurichthys polylepis</i> (Bleeker)		X	X	
<i>Heniochus chrysostomus</i> Cuvier			X	
* <i>H. singularis</i> Smith & Radcliffe				X
<i>Megaprotodon trifascialis</i> (Quoy & Gaimard)				
CIRRHITIDAE (Hawkfishes)				
<i>Cirrhitichthys falco</i> Randall		X	X	X
<i>Neocirrhites armatus</i> Castelnau		X		
<i>Paracirrhites arcatus</i> (Cuvier)	X	X	X	
<i>P. forsteri</i> (Bloch & Schneider)	X	X	X	
GOBIIDAE (Gobies)				
<i>Nemateleotris magnifica</i> Fowler		X	X	X
<i>Pogonoculius zebra</i> Fowler	X	X		
<i>Ptereleotris evides</i> (Jordan & Hubbs)	X		X	
<i>Valenciennea strigatus</i> (Broussonet)	X	X	X	X
HOLOCENTRIDAE (Squirrelfishes)				
<i>Adioryx caudimaculatus</i> (Ruppell)				X
<i>Flammeo sammara</i> (Forsskal)				X
LABRIDAE (Wrasses)				
<i>Anampses caeruleopunctatus</i> Ruppell	X			
<i>A. meleagrides</i> Valenciennes			X	X
<i>A. twisti</i> (Bleeker)		X		
<i>Bodianus axillaris</i> (Bennett)				X
<i>Cheilinus chlorourus</i> (Bloch)			X	X
<i>C. fasciatus</i> (Bloch)	X		X	X
<i>C. rhodocrous</i> Gunther	X	X	X	X
<i>C. trilobatus</i> Lacepede	X	X	X	X
<i>C. undulatus</i> Ruppell		X		
<i>Cirrhilabrus katherinae</i> Shepard & Randall	X	X	X	X
<i>Coris gaimard</i> (Quoy & Gaimard)		X	X	X
<i>Epibulus insidiator</i> (Pallas)	X	X	X	X
<i>Gomphosus varius</i> Lacepede	X	X		X
<i>Halichoeres biocellatus</i> Schultz			X	X
<i>H. hortulanus</i> (Lacepede)	X	X		X
<i>H. margaritaceus</i> (Valenciennes)	X	X		

FAMILY/SPECIES	DEPTH			
	15'	30'	60'	100'
H. sp. 1			X	
Hemigymnus melapterus (Bloch)	X	X		X
Hologymnosus doliatus (Lacepede)	X	X	X	X
Labroides bicolor Fowler & Bean	X	X		X
L. dimidiatus (Valenciennes)	X	X	X	X
Labropsis micronesica Randall		X		
L. xanthonotus Randall			X	X
Macropharyngodon meleagris (Valenciennes)		X	X	X
*Novaculichthys taeniourus (Lacepede)		X	X	
Pseudocheilinus evanidus Jordan & Evermann		X	X	X
P. hexataenia (Bleeker)		X	X	
Stethojulis bandanensis (Bleeker)	X	X	X	X
Thalassoma amblycephalum (Bleeker)	X	X		
T. lutescens (Lay & Bennett)	X	X	X	X
T. quinquevittatum (Lay & Bennett)	X	X		
*Labrid sp. 1	X			
*Labrid sp. 2			X	
LETHRINIDAE (Emperors)				
*Monotaxis grandoculis (Forsskal)				X
LUTJANIDAE (Snappers)				
*Lutjanus bohar (Forsskal)				X
*L. rivulatus (Cuvier & Valenciennes)				X
MALACANTHIDAE (False Whittings)				
*Malacanthus brevirostris Guichenot			X	
MONACANTHIDAE (Filefishes)				
*Cantherhines dumerili (Hollard)			X	
C. pardalis (Ruppell)	X	X	X	
Paraluteres prionurus Bleeker			X	
Pervagor melanocephalus (Bleeker)		X	X	
MUGILOIDIDAE (Sand Perches)				
Parapercis clathrata Ogilby	X	X	X	X
MULLIDAE (Goatfishes)				
Mulloidichthys flavolineatus (Lacepede)	X			
Parupeneus bifasciatus (Lacepede)	X		X	X
P. chryserydros (Lacepede)	X	X	X	X
P. pleurostigma (Bennett)	X		X	X
P. trifasciatus (Lacepede)	X	X	X	X
MURAENIDAE (Moray eels)				
*Lycodontis richardsoni (Bleeker)		X		
OSTRACIONTIDAE (Boxfishes, Cowfishes)				
Ostracion meleagris Shaw		X		X

DEPTH

FAMILY/SPECIES	15'	30'	60'	100'
POMACANTHIDAE (Angelfishes)				
Apolemichthys trimaculatus (Cuvier)	X		X	
*Centropyge bicolor Bloch	X			
C. flavissimus (Cuvier)	X	X	X	
C. heraldi Woods & Schultz			X	X
C. shepardii Randall & Yasuda			X	X
Pygoplites diacanthus (Boddaert)			X	X
POMACENTRIDAE (Damsel fishes)				
Amphiprion clarkii (Bennett)		X	X	
Chromis acares Randall & Swerdloff		X		
C. amboinensis (Bleeker)			X	
C. margaritifer Fowler	X	X		
*Chrysiptera leucopomus (Lesson)	X			
C. traceyi (Woods & Schultz)	X			X
Dascyllus reticulatus (Richardson)	X	X	X	
D. trimaculatus (Ruppell)	X		X	
Plectroglyphidodon dickii (Lienard)	X	X		
*P. imparipennis (Valliant & Sauvage)	X			
P. johnstonianus Fowler & Ball	X	X	X	
P. lacrymatus (Quoy & Gaimard)		X	X	X
Pomacentrus amboinensis Bleeker	X	X		
P. vaiuli Jordan & Seale	X	X	X	X
Pomachromis guamensis Allen & Larson	X	X	X	X
Stegastes fasciolatus (Ogilby)	X	X		
SCARIDAE (Parrotfishes)				
*Bolbometopon muricatus (Valenciennes)	X			
Cetoscarus bicolor (Ruppell)	X	X	X	
Scarus brevifilis (Gunther)	X	X		
S. ghobban Forsskal				X
S. gibbus Ruppell		X	X	
*S. oviceps Valenciennes		X	X	
S. psittacus Forsskal	X	X	X	X
S. rubrioviolaceus (Bleeker)	X	X	X	
S. schlegeli (Bleeker)	X	X	X	X
S. sordidus Forsskal	X	X	X	X
SCORPAENIDAE (Scorpionfishes)				
*Synanceia verrucosa Bloch & Scheneider			X	
SERRANIDAE (Groupers)				
*Cephalopholis argus (Bloch & Schneider)				X
C. urodelus (Bloch & Schneider)	X	X	X	X
Epinephelus fasciatus (Forsskal)		X	X	X
*Plectropomus melanoleucus (Lacepede)				X
Variola louti (Forsskal)				X
SIGANIDAE (Rabbitfishes)				
Siganus argenteus (Quoy & Gaimard)			X	X
SYNODONTIDAE (Lizardfishes)				
Synodus variegatus (Lacepede)		X	X	X

FAMILY/SPECIES	DEPTH			
	15'	30'	60'	100'
TETRAODONTIDAE (Smoother Puffers)				
<i>Arothron nigropunctatus</i> (Bloch & Schneider)		X		
<i>Canthigaster bennetti</i> (Bleeker)	X			X
<i>C. coronata</i> (Valliant & Sauvage)			X	
<i>C. janthinoptera</i> (Bleeker)		X		
<i>C. solandri</i> (Richardson)	X	X	X	X
<i>C. valentini</i> (Bleeker)			X	
ZANCLIDAE (Morrish Idols)				
<i>Zanclus cornutus</i> (Linnaeus)	X	X	X	X
Total No. Families	29	17	21	21
Total No. Species	153	80	92	96

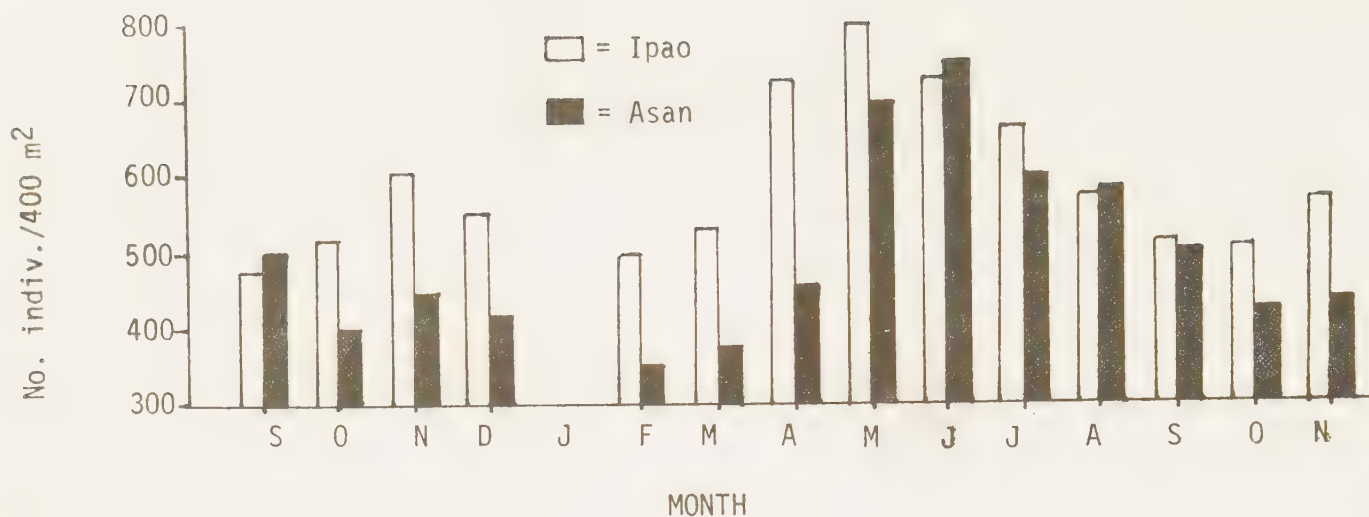


Figure 2. Monthly totals of individuals counted on Ipao and Asan transects at 30.5 m (100 ft) depth from September 1979 through November 1980.

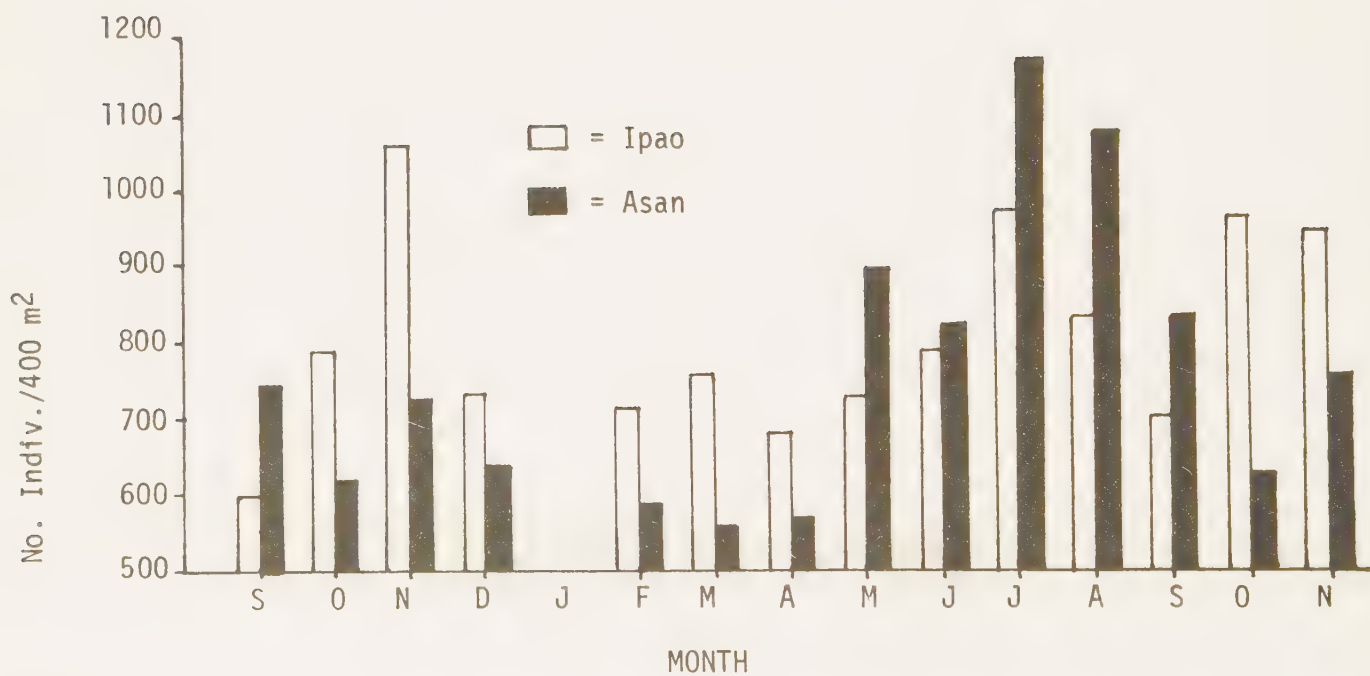


Figure 3. Monthly totals of individuals counted on Ipao and Asan transects at 4.6 m (15 ft.) depth from September 1979 through November 1980.

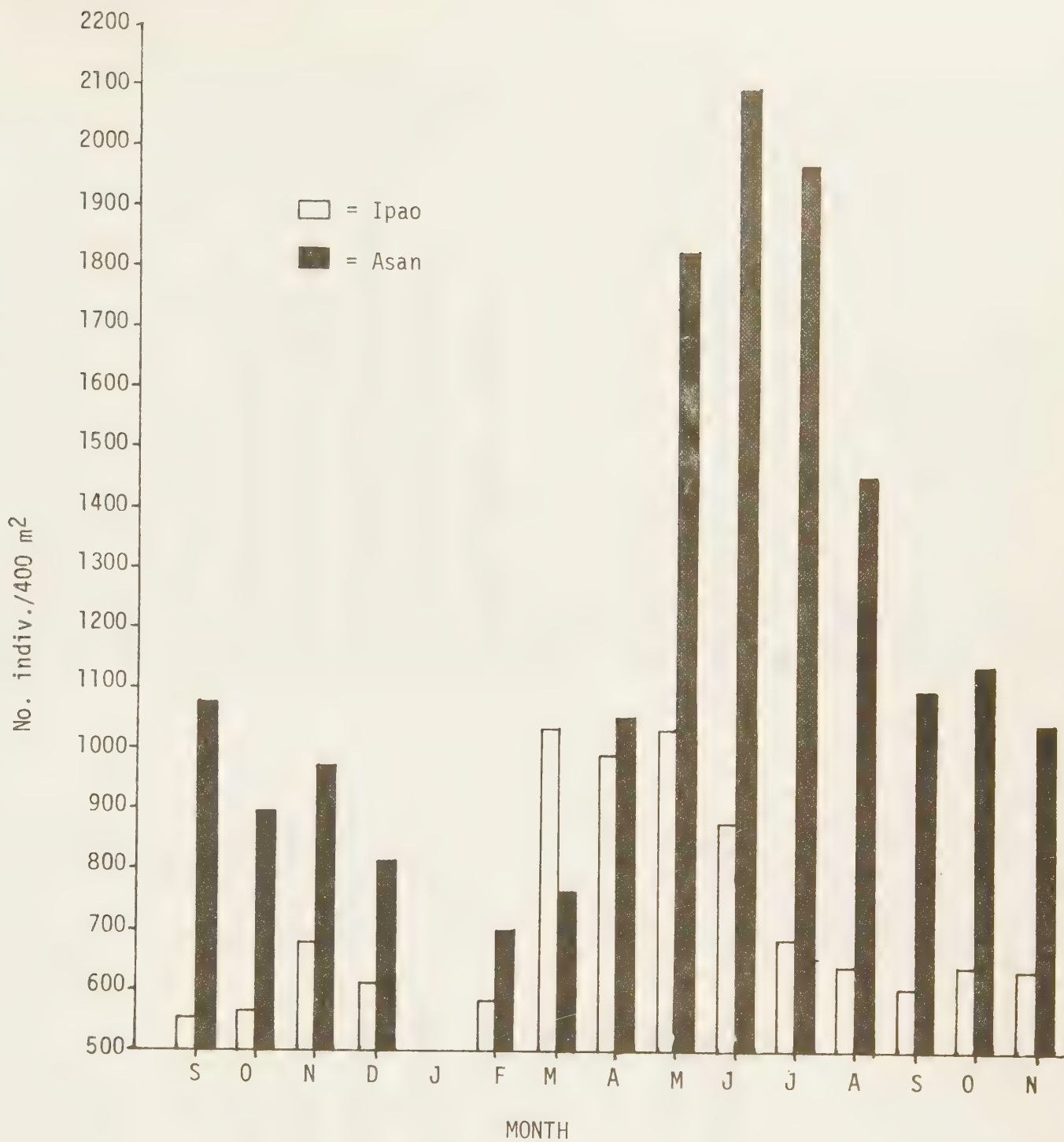


Figure 4. Monthly totals of individuals counted on Ipao and Asan transects at 9.1 m (30 ft) depth from September 1979 through November 1980.

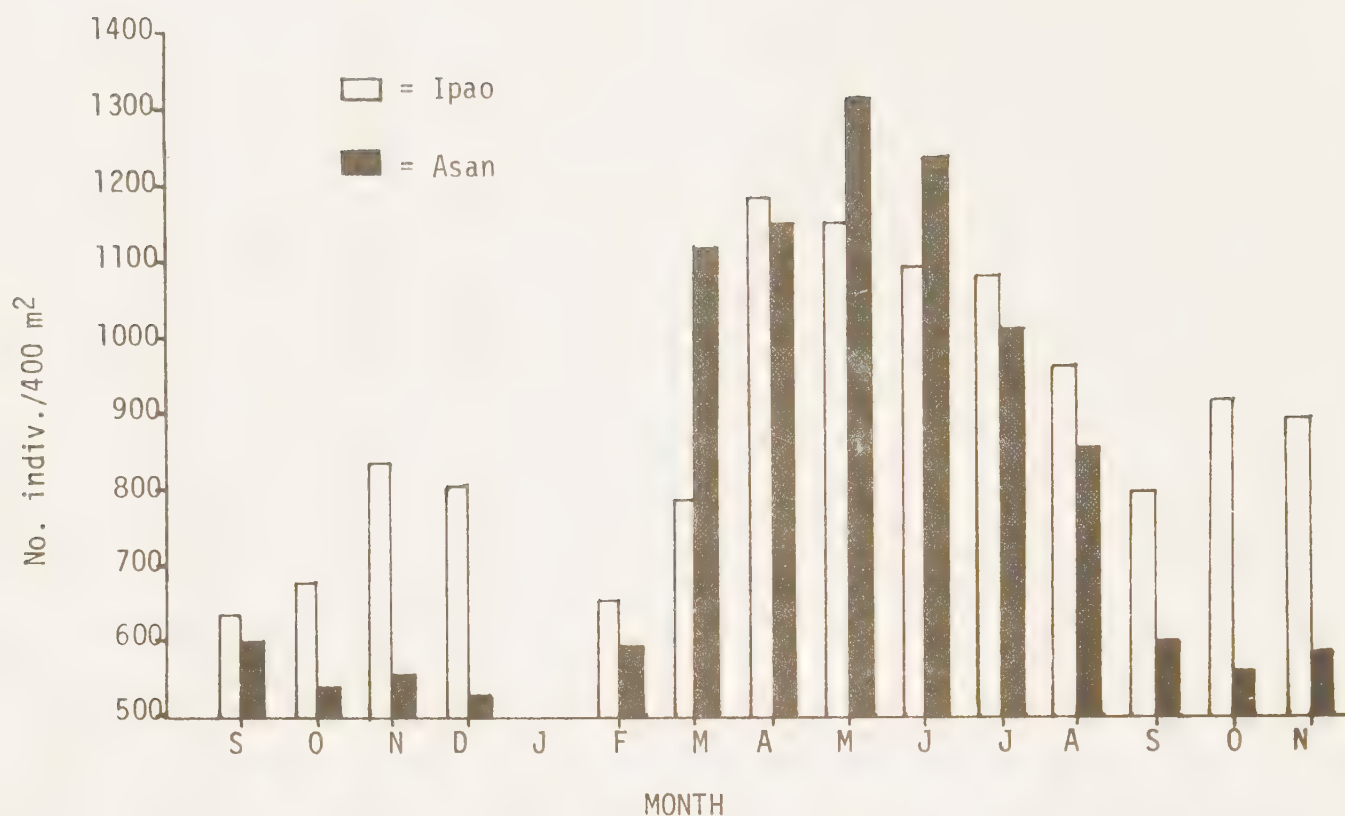


Figure 5. Monthly totals of individuals counted on Ipao and Asan transects at 18.3 m (60') depth from September 1979 through November 1980.



Figure 6. Mean monthly windspeed for the island of Guam. = wind speed; = % frequency of offshore wind.

would expect to find changes in current patterns which at least roughly correspond with the timing of observed wind shifts. Well developed current gyres are typical oceanographic phenomena found off the leeward sides of many Pacific islands. Thus, it is logical to assume that decreasing wind velocities would result in decreasing leeward offshore water transport which in turn would cause a lessening in relative gyre strengths. It follows that the reverse would be true during times of increasing wind velocities.

As a reproductive strategy it would be advantageous for leeward reef fishes to increase spawning activities with the onset of the windy season when increasing offshore transport of larvae would reduce the danger of reef-associated predation, and when well developed current gyres would reduce larval loss due to transport and possibly aid in returning them to suitable reef habitats. Recruitment would be expected to increase when prevailing winds and, therefore, offshore water transport and relative current gyre strengths begin to subside. On Guam, these times of change occur in the fall (around October) and the spring (around April). The fluctuations in fish densities observed during the study at these times are probably the result of increased spawning (fall/winter) and recruitment (spring/summer) which occurred in response to the physical effects of seasonal wind shifts.

Computer analyses of the data will be forthcoming. Hopefully, the interpretation of these analyses will clarify the relative importance a certain species, depth and/or general location may have in explaining the observed density fluctuations. These more detailed results will be presented and discussed in our next annual report.

RECOMMENDATIONS

Computer analyses of the data should be carried out. Based on the findings, relevant conclusions should be drawn regarding the seasonal variability of the reef fish community on Guam. The relationship of seasonal wind and current pattern shifts to the seasonal variability of recreationally important reef fish species, such as Caranx melampygus, Mulloidichthys flavolineatus, Siganus spinus, Selar crumenophthalmus and others should be examined.

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JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-18

SUB-PROJECT NO.: F

STUDY NO.: F-1

JOB NO.: 7

JOB TITLE: Evaluating effects of fishing Pressure between Reef Flat Habitats.

SUMMARY

Catch data and fish densities of some economically import reef fishes were compared between some heavily and lightly fished reef flats of Guam. Although the total catch by weight was greater on the heavily fished reef flats, the catch rates were much lower on the heavily fished reef flats. Whereas siganids played a much more important role in the catch by weight for all methods on the heavily fished reef, there was a lack of the large carnivores Caranx melampygus and Lethrinus horak in the catches on the heavily fished reefs as compared to the lightly fished reefs. Comparison of the fish densities indicated that the large size classes of the economically importance reef flat fishes were most affected by fishing pressure, for the total standing stocks were significantly less dense on the heavily fished reefs. The small size classes seemed less affected by the fishing pressure.

BACKGROUND

In recent years there have been reports of the decline of shallow-water reef fisheries in the Pacific islands. (Johannes 1978, Pauley 1979, R.E. Brock, pers. comm. 1981). In most cases, such declines were attributed to overfishing of the inshore reef environments. A similar fate has probably occurred on Guam's reef flats, and Ikehara and Kami (1970) stated: "These shallow inner reefs appear to be fully exploited at present and strong signs of overfishing are evident over most of the area."

The reef flats have historically been a very popular source of protein for the people of Guam. In the past, traditional fishing methods (cast net, gill net, surround net, spear, hook and line, etc.) assured Guam's inhabitants of an ample supply of reef fish most of the fish caught in this subsistence fishery was either consumed by the fisherman and family or was shared with the community and with other fishermen who helped with the catch. Sometime the fish was also used for social obligations such as funerals, marriages, and fiestas. "As Guam has been forced more and more into a monetary economy, a greater portion of this fish has been entering commercial markets" (Amesbury and Callaghan 1980). Although the fishery still maintains its subsistence nature, population growth (the present population exceeds 100,000) and the expanded reef fish market have increased the demand for reef flat fishes. Fishermen interviews on Guam have also indicated an overall decline in the reef flat fishery over the past years. On the advent of these changes there is a need for data on the state of Guam's reef flat fishery.

The subsistence nature of Guam's reef flat fishery has made it very difficult to obtain precise and accurate catch and effort data on Guam's reef flats. The data is obtained solely from fisherman interviews carried out by the Guam Division of Aquatic and Wildlife Resources (G.D.A.W.R.), and there has been a lack of manpower and funding to maintain a consistent and efficient fisherman interview system. Consequently only very general comparison can be made with the past and present creel census data. Also, the creel census data has been collected almost entirely from the most accessible and most heavily fished reefs of Guam. Major declines in the fishery on some of these heavily fished reef flats may have appeared well before accurate creel census data collection was initiated.

OBJECTIVES

1. To assess the impacts of reef flat fishing pressure by comparing fishing data and the standing stocks of some economically important reef fishes on reefs which have been subject to heavy fishing pressure with reefs, which because of their inaccessibility, have been subject to relatively light fishing pressure.

PROCEDURES

To ensure that the comparisons made between the heavily and lightly fished reef flats were meaningful, each reef flat selected had to meet certain criteria. First, reef flat pairs to be compared had to have similar physical parameters and similar biological regimes or habitats. Second, one reef flat per pair must have received, both presently and in the past, significantly greater fishing pressure than the other.

Extensive field observations were used to select the reef flat pairs and divide them into specific habitats. Each reef flat pair has similar wave exposure, surface drainage, and original substrate type. Subsequently each reef flat pair is in the same biotope type (Figure 1). Because each pair is found within the same biotope and contains comparable habitats, it is assumed that there should also be comparable fish populations within each reef flat pair and especially within the comparable habitats.

Past creel census data, DAWR aerial surveys (1965-66, 1975-76, 1978-79), and knowledge of the relative accessibility of the various reef flats enabled the investigator to estimate past differences in fishing pressure between the various reef flat pairs. Present difference were obtained during the course of the study.

The reef flats composed in this study include:

Pair 1: N.NCS (heavier pressure) vs Uruno (lighter pressure)

These reef flats are located in the northern, leeward biotope of Guam (Biotope A in Figure 1). The nearly terrestrial substrate is largely limestone; therefore, the reefs are influenced by a lens drainage system. Uruno is surrounded by military bases and private land. Consequently, it has been and presently is closed to all fishing activities except by specific landowners or guests. N.NCS is accessible and closer to more populated villages; hence, it has received much heavier fishing pressure in the past than Uruno.



Figure 1. Map of Guam showing reef flat pairs and their respective biotopes (A,B,C).

Pair 2: Rizal (heavier pressure) vs Facpi (Lighter pressure)

These are southern leeward reef flats influenced by direct terrestrial water runoff (Biotope B in Figure 1). Rizal is easily accessible, whereas, Facpi is surrounded by private lands with no access road. Therefore, fishing pressure have been more concentrated at Rizal than at Facpi.

Pair 3: Togcha Channel (heavier pressure) vs Ajayan Channel (lighter pressure)

These fringing reef river channels are located in the southern, windward biotope of Guam (biotope C in Figure 2), and are characterized by direct terrestrial runoff (the river channel) because of the volcanic nature of the nearby terrestrial substrate. Both reefs are fairly accessible; however, Togcha is farther north and closer to the dense population centers. Consequently, Togcha has received much more fishing pressure in the past than Ajayan (creel census data and DAWR aerial surveys 1965-66, 1975-76, 1978-79).

Standing stocks of economically important reef flat species were assessed by underwater transects. The transects were performed by swimming freely at a constant speed within the habitat being censused. Fishes ahead and three meters to each side were counted and categorized by size. Each count lasted five minutes, and four replicates were completed for each habitat on census days. Transects were run once every two months from September 1980 to August 1981 and occurred in the early morning or late afternoon. The low densities of fishes on the reef flats and small volumes of water allowed the investigator to census a distance of approximately 100 meters in five minutes. This was tested by doing replicate swims at the same speed the censuses were swum and measuring the distances traveled. Estimation of the standing stock of each fishery group in each habitat was made by determining the mean densities of all 24 counts or the average number of fish per 600 m².

Selection of the economically important reef flat fishes was based on fishermen interviews and past catch records, and selection of fish size categories was based on field observation of the relative sizes of the reef flat species, past catch record, and literature. A list of these reef flat fishes and their relative size categories is given in Table 1. The reef flat fishes were also placed into fishery groups. The fishery groups consists of certain types of fishes of either the same species, genus, or family that are all effectively caught by similar fishing methods. Fishery groups were created to allow for better statistical comparison in cases where single specie densities were extremely low. Table 2 distinguishes which reef fishes are found in each fishery group and also indicates what fishery groups make up the carnivores, herbivores, and total standing stocks. Scolopsis cancellatus, which is a relatively unfished and economically unimportant species (fishermen interview and field observations) was treated separately.

Fishing pressures were monitored during the study by interviewing fishermen three times a month (from Sept. 1980 to Aug. 1981) on each of the reef flats and habitats. Effort, catch by fishery group (kg.), catch rates or catch per unit effort (CPUE) and fishing method was evaluated for each habitat on all reef flats. The relative importance of each fishery group (percent by weight) in the total catch was determined for each reef flat to compare

Table 1. Reef flat fishes and size categories

Small: <4" Medium: 4"-6" Large: >6"

Acanthurus nigrofuscus

A. nigroris

A. nigrocaudus

A. triostegus

A. guttatus

A. sp.

Ctenochaetus striatus

Siganus spinus

S. argenteus

Small: <4" Medium: 4"-7" Large: >7"

Scolopsis cancellatus

Small: <6" Medium: 6"-8" Large: >8"

Acanthurus lineatus

Small: <6" Medium: 6"-9" Large: >9"

Lutjanus fulvus

L. monostigmus

Lethrinus harak

Scaridae

Cheilinus sp.

Hemigymnus melapterus

Labridae

Serranidae

Caranx melampygus

Mugilidae

Liza vaigiensis

Mulloidichthys flavolineatus

Parupeneus trifasciatus

P. bifasciatus

P. barberinus

Small: <8" Medium: 8"-12" Large: >12"

Naso unicornis

N. lituratus

Cheilio inermis

Kyphosus cinerascens

Table 2. Reef fishes and corresponding fishery groups

<u>Reef Fishes</u>	<u>Fishery Groups</u>		
<u>Acanthurus guttatus</u>			
<u>A. nigroris</u>	ACS		
<u>A. nigrocaudus</u>			
<u>A. sp.</u>			
<u>A. nigrofuscus</u>	ACN		
<u>Ctenochaetus striatus</u>	CTS	Herbivores	
<u>Acanthurus lineatus</u>	ACL	(Herb)	
<u>A. triostegus</u>	ACT		
<u>Naso unicornis</u>			
<u>N. lituratus</u>	NAS		
<u>Siganus spinus</u>	SIG		TOTAL
<u>S. argenteus</u>			
<u>Kyphosus cinerascens</u>	KYP		
<u>Scaridae</u>	SCA		
<u>Cheilinus sp.</u>			
<u>Cheilio inermis</u>	LAB		
<u>Hemigymnus melapterus</u>			
<u>Lutjanus fulvus</u>			
<u>L. monostigma</u>	LUT	Carnivores	
<u>L. fulviflamma</u>		(Carn)	
<u>Lethrinus harak</u>	LEH		
<u>Serranidae</u>	SER		
<u>Caranx melampygus</u>	CAM		
<u>Mulloidichthys</u>			
<u>flavolineatus</u>	MUF		
<u>Parupeneus trifasciatus</u>			
<u>P. bifasciatus</u>	PAS		
<u>P. barberinus</u>			
<u>Liza vaigiensis</u>			
<u>Mugilidae</u>	MUG		
<u>Scolopsis cancellatus</u>	SCO	Unfished	

possible differences between heavily and lightly fished reefs.

RESULTS

It should be mentioned that the results presented in this report are a summary of the more specific results actually obtained in the study. A more detailed report in the form of a master thesis will be made available at a later date.

Table 3 clearly shows that the heavily fished reefs received much greater fishing effort than the lightly fished reefs. By method, surround net (which was not used on the lightly fished reefs), hook and line, and spear showed the most obvious differences in effort between heavily and lightly fished reefs.

The total weight of fish caught was actually larger on the heavily fished reefs than the lightly fished reefs (Table 3). Of the comparable methods, spearfishing caught more than 2 times the fish by weight on the heavily fished reefs than the lightly fished reefs. On the other hand the gill net accounted for a much larger catch by weight on the lightly fished reefs than the heavily fished reefs. The catches for hook and line and gill net were rather close by weight on the heavily and lightly fished reefs. The surround net accounted for the largest catch by weight for all methods on both the heavily and lightly fished reef flats.

The catch rates were much lower on the heavily fished reef flats than the lightly fished reef flats (Table 3). This trend was seen for all the comparable methods as well. On the heavily fished reef flats the cast net had the highest catch rate in Kg/man-hour and the surround net had the highest catch rate in Kg/gear hour. On the lightly fished reef flats all the methods had very close catch rates in both Kg./man-hour and Kg./gear-hour, except for the gill net which had the highest catch rate in Kg./gear-hour.

There were major differences in the relative importance that certain fishery groups played in the total catch by weight for all methods between the heavily fished reefs and the lightly fished reefs (Table 4). The large importance of the siganids (mostly Siganus spinus) in the total catch on the heavily fished reefs in relation to the lightly fished reefs was the most apparent contrast. Caranx melampygus and Lethrinus harak on the other hand showed much more importance in the total catch on the lightly fished reefs than on the heavily fished reefs. Although Mulloidichthys flavolineatus was third in relative importance on both the heavily fished reefs and the lightly fished reefs, it made up a larger percent of the catch on the lightly fished reefs. Acanthurus triostegus was a very important component of the total catch on both the heavily (second in importance) and the lightly (first in importance) fished reef flats. The siganids and A. triostegus accounted for 64% of the total catch by weight on the heavily fished reefs, while these relatively small herbivores (Table 1) made up only 31% of the total catch on the lightly fished reefs. The large carnivores C. melampygus and L. harak made up 29.4% of the total catch by weight on the lightly fished reefs and only 5.1% on the heavily fished reefs. The relative importance of the fishing groups on the individual reef flat pairs is shown in Table 4 as well.

Table 3. Effort and catch results of all heavily fished reefs vs all lightly fished reefs.

METHODS	All Heavily Fished Reefs				All Lightly Fished Reefs			
	EFFORT		CATCH		EFFORT		CATCH	
	Man- Hrs.	Gear- Hrs.	Total Wt. (Kg.)	C.P.U.E. Kg./M-H Kg./G-H	Man- Hrs.	Gear- Hrs.	Total Wt. (Kg.)	C.P.U.E. Kg./M-H Kg./G-H
H&L	182	182	16.96	.10	21.5	21.5	20.40	.95
SP	62	62	11.52	.19	5.5	5.5	4.79	.87
CN	37.5	37.5	16.52	.44	19.0	19.0	17.60	.93
GN	65	31	19.51	.30	33	20.5	30.59	.93
SN	153	31.5	36.91	.24				1.49
TOTAL	499.5	344	101.42	.21	79	66.5	73.38	.93
				.30				1.10

Table 4. Order of Relative Importance (percent (%) of total catch weight) of the Fishery Groups Caught by All Methods on the Heavily and Lightly Fished Reef Flats.

Pair 1			Pair 2			Pair 3			All Heavily Fished Reefs (H)			All Lightly Fished Reefs (L)		
Rizal (H)	Facpl (L)	N.NCS (H)	Uruno (L)	Togcha (H)	Ajayan (L)	Fishery Group %	Fishery Group %	Fishery Group %	Fishery Group %	Fishery Group %	Fishery Group %	Fishery Group %	Fishery Group %	Fishery Group %
SIG 39	ACT 56	SIG 38	CAM 31	SIG 34	LEH 21	34	31	SIG 34	SIG 35	SIG 35	ACT 25	ACT 25	ACT 25	ACT 25
ACT 29	SIG 21	ACT 26	ACT 29	ACT 30	MUF 20	30	29	ACT 30	ACT 29	ACT 29	CAM 20	CAM 20	CAM 20	CAM 20
CAM 9	SCA 13	MUF 14	MUF 11	NAS 9	ACT 13	9	11	NAS 9	MUF 6.8	MUF 6.8	MUF 14	MUF 14	MUF 14	MUF 14
SCA 8	CAM 5	SCA 6	NAS 6	SCA 6	CAM 9	6	6	SCA 6	SCA 6.1	SCA 6.1	LEH 9.4	LEH 9.4	LEH 9.4	LEH 9.4
LAB 5	ACS 3	MISC 4	ACS 4.6	LAB 5	SCA 7	5	4.6	LAB 5	NAS 5	NAS 5	SIG 6	SIG 6	SIG 6	SIG 6
ACL 3	MISC 2	CAM 3.3	LAB 4.5	CAM 3.3	SIG 6	3.3	4.5	CAM 3.3	LAB 4.4	LAB 4.4	SCA 6	SCA 6	SCA 6	SCA 6
CTS 1.7		LAB 2.9	SCA 3.0	MUF 3	KYP 5	3	3.0	MUF 3	CAM 3.7	CAM 3.7	NAS 4.8	NAS 4.8	NAS 4.8	NAS 4.8
MISC 1.7		KYP 2.5	SIG 2.6	LEH 2	NAS 4.8	2	2.6	LEH 2	MISC 2.3	MISC 2.3	LAB 4.0	LAB 4.0	LAB 4.0	LAB 4.0
PAS 1.5		ACL 2.0	LEH 2.0	MUG 1.6	LAB 4.6	1.6	2.0	MUG 1.6	KYP 1.7	KYP 1.7	ACS 3.0	ACS 3.0	ACS 3.0	ACS 3.0
SCO 1.4		SER .7	MISC 1.6	KYP 1.5	MISC 3	1.5	1.6	KYP 1.5	LEH 1.4	LEH 1.4	KYP 2.4	KYP 2.4	KYP 2.4	KYP 2.4
ACN 1.1		LEH .6	ACL 1.5	MISC 1.3	SER 2.4	1.3	1.5	MISC 1.3	MUG 1.0	MUG 1.0	MISC 2.0	MISC 2.0	MISC 2.0	MISC 2.0
		PAS .2	SER 1.2	ACS 1.2	MUG 2	1.2	1.2	ACS 1.2	ACL .9	ACL .9	SER 1.6	SER 1.6	SER 1.6	SER 1.6
			KYP .9	SCO .8	ACS 1.2	.8	.9	SCO .8	ACS .7	ACS .7	ACL .8	ACL .8	ACL .8	ACL .8
			LUT .8	SER .6	CTS 1.0	.6	.8	SER .6	SCO .6	SCO .6	MUG .6	MUG .6	MUG .6	MUG .6
			PAS .7	PAS .5	ACN .4	.5	.7	PAS .5	SER .5	SER .5	LUT .5	LUT .5	LUT .5	LUT .5
				CTS .4	LUT .2	.4		CTS .4	PAS .4	PAS .4	PAS .3	PAS .3	PAS .3	PAS .3
				ACN .3		.3		ACN .3	CTS .3	CTS .3	CTS .2	CTS .2	CTS .2	CTS .2
									ACN .2	ACN .2	ACN .1	ACN .1	ACN .1	ACN .1

The mean densities of Table 5 are based on the average of all the mean densities in all the habitats in which the various fishery groups were found. Because certain fishery groups were not found in all habitat types the number of comparable comparison tests differed among the fishery groups and size classes. Thus the sum of the means of the various fishery groups do not equal the density for the total standing stocks, herbivores, and carnivores, since a different N size was used to compute the various densities.

The paired comparisons test accounts for the differences of the mean densities in all the comparable habitats and determine if such differences are consistently and thus significantly different. The siganids had a much larger average density in the heavily fished reefs; but because of the tremendous variance in the mean densities of this juvenile fish, no significant differences were seen between the heavily and lightly fished reefs. If the mean densities exhibit much variance and/or are not consistently greater in either all the heavily or all the lightly fished habitats then the test will not show significance even though the difference between means may be quite substantial.

For the small size classes the only fishing group that was significantly more dense in the lightly fished reefs was the fishery group Acanthurus spp. (Table 5).

For the medium size classes the two large carnivores Lutjanidae and Caranx melampygus were significantly more abundant in the lightly fished reefs than the heavily fished reefs. Scolopsis cancellatus was definitely more dense in the heavily fished habitats, however, the large difference in means was the result of large difference in a few habitats and was not consistent throughout all the comparable habitats.

The size class that obviously showed the most significant difference was the large size class (Table 5). The total standing stocks and the herbivores were significantly more dense in all the lightly fished habitats. The fishery groups A. triostegus, Scaridae, Labridae, L. horak, Serranidae, and Parupensius spp. were all significantly more abundant in the lightly fished habitats.

RECOMMENDATION

The lightly fished reef flats of this study and others should be monitored on a regular basis to substantiate the findings of this study. The species that were significantly less dense on the lightly fished reefs could be used as indicator species to determine the affects of fishing pressure on both heavily and lightly fished reefs. Even though the large size classes are reduced in number on the heavily fished reef, recruitment proved to be unaffected. This suggests that recruitment may be facilitated by adults from outlying areas and perhaps even the unaccessible or lightly fished reefs. As Guam's population grows and the unaccessible reefs become more accessible to fishing pressure, adults may be depleted in these reefs as well, which in turn may start to affect recruitment to all reefs of Guam. To prevent such a occurrence, fishery managers should attempt to establish reef flats in inaccessible areas as refuge sites.

Table 5. Mean densities (number of fish per 600 m²) for all size classes for each fishery group, (herbivorous, carnivores and total standing stocks) for all heavily and lightly fished habitats combined. Significance levels are the result of paired comparison tests between mean densities of all habitats in which the fishes are found. Some fishery groups showed no significant differences yet the differences between the means were quite obvious. This was a result of the large variances attributed to the mean densities of certain fishery groups.

Fishery Groups	SMALL			MEDIUM			LARGE		
	H	N	L	H	N	L	H	N	L
ACS	.44	9	.59*	.44	8	.60	.26	7	.53
ACN	.56	8	1.34	.75	7	1.54	.42	6	.74
CTS	.89	9	.90	.82	7	1.20	.57	6	.68
ACL	.45	8	.61	.27	7	.66	.25	7	.47
ACT	6.28	11	9.29	5.31	11	6.02	1.35	11	2.79*
NAS	.97	8	1.55	.24	6	.90	.11	7	.54
SIG	18.48	10	3.39	2.21	10	1.08	2.08	8	1.90
KYP	.13	4	.21	.10	5	.24	.18	4	.25
SCA	7.85	10	7.01	1.85	9	3.04	1.05	8	2.23*
LAB	.73	9	.93	.51	9	.69	.13	9	.47**
LUT	.25	6	.26	.19	6	.35	.01	4	.08
LEH	.20	9	.74	.26	10	1.45*	.07	9	.90*
SER	0	1	.04	.04	5	.23	.02	3	.18**
+SCO	1.31	9	.61	5.39	10	1.78	1.39	7	.71
MUF	2.87	7	2.09	1.75	8	1.28	1.10	8	1.47
PAS	.43	10	.58	.19	10	.30	.10	8	.24*
MUG	.47	5	.43	.78	6	.52	.43	4	.59
Total	36.57	11	28.59	13.18	11	16.47	5.82	11	10.36*
Herb	25.69	11	16.22	8.95	11	10.21	3.85	11	6.05*
Carn	3.52	11	4.08	2.24	11	3.51	1.06	11	2.48

+*Scolopsis cancellatus* (SCO) is not included in total herb or carn for it is an unfished species.

Significance levels: .05 (*) .01 (**)

N Number of comparable habitats

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Report prepared by: Stephen E. Katnik

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-18

SUB-PROJECT NO.: F

STUDY NO.: F-II

JOB NO.: 1

JOB TITLE: Limnological Survey of the Major Streams and Rivers

PERIOD COVERED: October 1, 1980 to September 30, 1981

BACKGROUND:

An ecological survey of the Agfayan River mouth was conducted by Aquatic & Wildlife Resources (DAWR) from July 1, 1968 to June 30, 1972. Salinity, pH and temperature data, as well as lists of organisms collected or observed in the river mouth were included in the Annual DAWR Progress Reports. This study dealt primarily with the estuarine system.

In a preliminary study to rehabilitate the Masso River Reservoir into a public fishing and recreation area (July 1, 1971 to June 30, 1972), small gobies, eels and shrimp are mentioned as the principal inhabitants of the reservoir and feeder streams.

A limnological survey of the major streams and rivers of Guam was initiated during the period of June 30, 1974 to July 1, 1975. The Geus River, located in the southern tip of the island, and the Lonfit River in the central highlands, were investigated. Six species of fish, three species of shrimp and an aquatic gastropod were observed or collected from the Geus River. Five of the six species of fish, and two of the three species of shrimp present in the Geus River were also collected or observed from the Lonfit River. Two species of aquatic gastropods were taken in the Lonfit River.

The Geus River was found to be unsuitable for stocking gamefish or development as a fishing area. The Lonfit River was judged suitable for a stocking and development program, however, this was deferred because of limited access to the river. The University of Guam Marine Laboratory Technical Report No. 16 (1974) discusses the physical, limnological and biological components of the Geus River drainage basin. Organisms were collected and catalogued from established stations on the Ylig, Geus and Umatac Rivers during FY 77. Preliminary stomach content analyses of three fish species, Microsicydium elegans, Eleotris fusca and Chonophorus guamensis were performed during the report period. The collection of air and water temperatures and flow readings was initiated during this period. Breeding and reproduction observations were made of one species of fish.

Water temperatures, flow rates and biological data were collected monthly from permanent monitoring stations on the Geus and Umatac Rivers during FY 1978. The Ylig River was monitored at 3 stations during November 1977 and March 1978.

Seven sampling stations were established on the Ugum and Bubulao River system. The names of the organisms present were listed in our Job Progress Report for FY 79. Observations on the spawning of Microsicydium elegans from the Geus River were included.

During FY 80, preliminary air and water temperature data and water samples were collected from two experimental watersheds in southern Guam. Floral and faunal collections were also made. Data from four vegetational transects were collected. Nitrate, nitrite, ortho and total phosphates, pH, conductivities, turbidity and hardness parameters were determined from water samples.

RESULTS

This job was inactive during the period covered due to lack of personnel.

RECOMMENDATION

This job should be continued at a relatively low level, to permit periodic limnological surveys to be conducted.

Report prepared by: Alan J. Hosmer

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-18
SUB-PROJECT NO.: F
STUDY NO.: F-II
JOB NO.: 2

JOB TITLE: Masso River Watershed Studies

PERIOD COVERED: October 1, 1980 to September 30, 1981

BACKGROUND

During FY 79, the fauna of Masso Reservoir and its feeder streams was sampled. Aquatic organisms collected include two eels (Anguilla marmorata and A. bicolor), three gobies (Chonophorous guamensis, Microsicydium elegans, and Sicyopterus macrostetholepis) an eleotrid (Eleotris fusca), several shrimps (Atya sp., Caridina sp., and Macrobrachium lar), tadpoles of Bufo marinus, and a variety of insect larvae and small invertebrates.

OBJECTIVES

To formulate fisheries and recreational management plans for present and future reservoirs.

RESULTS

This job was largely inactive during the period covered due to lack of personnel. Occasional inspections of the stocked, red, hybrid tilapia were made to determine initial, stocking mortality. Approximately six dead tilapia were seen within one month of stocking, after which no further mortality was observed. Nesting tilapia, and fry were seen within two months of stocking.

RECOMMENDATION

As Masso Reservoir will soon be opened for public fishing, this job should be continued.

Report prepared by: Alan J. Hosmer

GUAM FISHERIES DEVELOPMENT
PROJECT F-2-D-3
Federal Aid in Sport Fish Restoration Act

PROGRESS REPORT
DEVELOPMENT PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: F-2-D-3
SUB-PROJECT NO.: FD-1

SUB-PROJECT TITLE: Masso Reservoir Development

PERIOD COVERED: October 1, 1980 to September 30, 1981

SUMMARY

Masso Reservoir was stocked with approximately 1000 red hybrid tilapia, however about half of these fish were removed by vandals. Management agreements for the park area were drafted. Erosion and siltation control measures were continued.

BACKGROUND

Fishing continues to be an important activity for many people on Guam. It is highly valued as a recreational activity and remains an important source of food. Saltwater fishing is available but, there is no standing body of freshwater accessible to the general public. If a fishable freshwater pond was available, it would be unique in providing fishing opportunities for the very young, senior citizens, and handicapped people who are unable to fish in the ocean where high waves and strong currents are often present.

The Masso Reservoir was constructed by the U.S. Navy in the early 1940's for use as a potable water reservoir. It was abandoned in 1951 because siltation had made it unsuitable for water storage. Siltation continued until only $\frac{1}{4}$ - $\frac{1}{2}$ acre area of open water existed, surrounded by a marsh of elephant grass (Phragmites karka). The Reservoir and surrounding by a marsh of elephant grass forgotten except for an occasional eel or shrimp fisherman setting traps in the reservoir or feeder streams.

In 1978, the Black Construction Company, working under contract to the Aquatic and Wildlife Resources Division, cleared about two acres of the pond by removing the Phragmites grass. At this time the retaining wall, spillway, and sluice gate were repaired. When full, the pond has an open water surface area of about two and one half acres and a maximum depth of about eight feet. There remain another two acres of marsh habitat at the mouths of the two tributaries which empty into the reservoir.

Aquatic organisms found in Masso Reservoir and its feeder streams include two eels (Anguilla marmorata and A. bicolor), three gobies (Chonophorous guamensis, Microsicydium elegans, and Sicyopterus macrostetholepis), an eleotrid (Elotris fusca), several shrimps (Atya sp., Caridina sp., and Macrobrachium lar), tadpoles of Bufo marinus, and a variety of insect larvae and small invertebrates. The vegetation is dominated by the reed Phragmites karka in wet areas, and by Leucaena leucocephala (tangan-tangan) on dry ground. Other trees in the area include Hibiscus tiliaceus, Pandanus sp., Spathodea campanulata (African tulip), Casuarina equisetifolia and Pithecellobium dulce.

Between July and December of 1978, YCC and CETA personnel planted hundreds of trees and shrubs on the hillsides of the Masso watershed. A detailed description of this work was included in the 1979 Aquatic and Wildlife Resources Report.

In March, 1978, a Draft Environmental Impact Statement for the introduction of exotic fish into Masso Reservoir was submitted to the U.S. Fish and Wildlife Service (FWS). Under this proposal, approximately 20 species of exotic game and forage fish would have been planted. However, the DEIS was reviewed by the FWS and found to be inadequate in its treatment of the potential problems. It was suggested that the required process to complete an acceptable EIS would be far more time consuming and costly than the project warrants. In view of this attitude adopted by the FWS, and after considering the numerous professional evaluations of the stocking, it was decided not to stock the Reservoir with exotic species.

OBJECTIVES

The objectives of the Masso Project have included the following:

1. Create a pond with several acres of open water suitable for stocking with forage and game fish;
2. Repair the retaining wall, spillway and sluice gate;
3. Create a variety of fish habitats within the pond with brush shelters, rock piles, etc.,
4. Fence in the spillway area to remove an "attractive nuisance" which is potentially dangerous to children and others;
5. Landscape the area around the pond, and plant attractive fruit, shade, and ornamental trees and shrubs;
6. Stock the pond with fish;
7. Monitor the fish populations in the pond, and the fishermen's use of the pond.

RESULTS

As an alternative to the proposed stocking of exotics, Masso Reservoir was stocked with local tilapia. These tilapia result from hybridization of Sarotherodon mossambica and S. nilotica, and are currently being raised commercially on Guam by two aquaculture companies. Offspring of this hybridization are referred to as "cherry snapper" and are mottled or uniform red and predominantly male. Both attributes make this hybrid advantageous for stocking in Masso. Red is a locally preferred color for fish and monosex stocking should reduce the common problem of stunted fish due to overpopulation.

On November 5, 1980, 400 hybrid tilapia, averaging approximately 15 cm in total length and 50 g in weight were placed in the pond. Unfortunately, vandals poisoned the pond and removed most of the fish in April 1981. A second stocking was completed on May 20, 1981, when 662 hybrid tilapia were released. These fish averaged 109g in weight.

Although each fish was sexed prior to its release we realize that 100% accuracy is rarely obtainable, and some reproduction was expected. Within two months of the second stocking, nesting adults and tilapia fry were observed during routine observations.

Erosion of the surrounding land and the resultant siltation of the Reservoir continue to be a problem. To help alleviate this problem additional plantings of shade and fruit trees were made in August 1981. Approximately 500 trees were planted in the watershed by YCC personnel.

The Masso Reservoir and immediately adjacent land (26 acres) is currently being transferred to Government of Guam ownership and will be managed by the Dept. of Parks and Recreation. A draft, Memorandum of Understanding between the Departments of Agriculture and Parks and Recreation has been prepared, concerning management of the park. Ultimate plans call for the development of picnic, camping and hiking facilities, in conjunction with the recreational hook and line fishing.

RECOMMENDATIONS

Masso Reservoir should be opened to public fishing as soon as management and maintenance agreements with the Department of Parks and Recreation are finalized. Periodic sampling and creel censuses should be conducted to determine the state of the fish stock, and fishing pressure. Occassional restocking of the pond may be necessary.

Report prepared by: Alan J. Hosmer

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: F-2-D-3
SUB-PROJECT NO.: FD-2

JOB TITLE: Construction of Fish Aggregating Devices

PERIOD COVERED: October 1, 1980 to September 30, 1981

SUMMARY

Four tire-type FAD, with redesigned mooring systems, were built and deployed this FY 81. Three of these continue to remain on station after five months. As the trade winds began in September and the general fishing on Guam improved, fishing in the close vicinity of the FAD improved. Better catch reports included 23 wahoo weighing 113 Kg caught in four hours of trolling by a FAD.

Data on buoy performance was collected in three ways, by handing out self addressed FAD catch cards, conducting fishermen interviews and by diving under and fishing the FAD ourselves. Thus far, the two former means have met with minimal success. The latter method is producing information on the behavioral characteristics of the fish associated with the FAD.

BACKGROUND

The Guam Division of Aquatic and Wildlife Resources received \$21,500 in FY 1979 from the Pacific Tuna Development Foundation (PTDF) for the construction and deployment of offshore Fish Aggregating Devices (FAD). As these funds became depleted in FY 80, more of the project's expenses were derived from Dingle-Johnson (D-J) funds.

The first prototype FAD (Type 1 FAD) were fashioned after Hawaii's three, 55-gallon drum design. In FY 79, three FAD of this type were built at a cost of \$2,739.00 each, exclusively from PTDF funds. Following the design evolution of the Hawaiian system, a single Type 2 FAD was constructed in FY 80 at a cost of \$2,496.00. This Type is constructed from a large (26.5" x 25") tire casing filled with foam, capped above and below with ¼" steel plate. A counter weight extends below and a radar reflector and light are above.

Buoys were deployed at 3 locations on the leeward side of Guam; Facpi Point, Haputo Point and the North end. All broke loose, however, the Facpi FAD was redeployed and subsequently lost again. Overall there were 4 deployments and 4 breakaways, with two recoveries. The longest a buoy remained on station was four and one half months.

Fishermen interviews and visual observations by biologists using SCUBA assessed the effectiveness of the FAD. An estimated catch of 700 Kgs (mostly mahimahi) was landed from 180 visits made to the buoys over a 60 day period. Visual observations identified many of the species associated with the buoy.

OBJECTIVES

1. To aggregate commercially important pelagic fishes at point locations accessible to fishermen.
2. To follow the succession of fishes associated with the FAD.
3. To experiment with non-trolling fishing techniques.

PROCEDURES

Four Type 3 FAD, referred to as small-tire, Type 2 FAD in the FY 80 report, were built with D-J funds during this report period. Type 3 FAD are made from 24.5" x 25" tire casings filled with foam, similar to the Type 2 FAD (Figure 1). The new mooring line design is the primary modification and was based on the final recommendations presented at the National Marine Fisheries Service (NMFS) fish aggregating device workshop held in Honolulu in October 1980. The new mooring system consists of 3/4" polypropylene line with a 1:1.13 scope ratio, 1/2" chain, 200 feet of cable at the mooring block, fibreglassed or welded shackles, stainless steel ballbearing swivels and splices that are whipped and coated with two layers of thick rubber contact cement (Figure 2). A construction cost breakdown is presented in Table 1.

Site selection was influenced by two major considerations. The first was compliance with restrictions imposed by the U.S. Navy, which would not permit buoy placement at the preferred sites near the 1000 fathom contour, within 5 miles of the coast. A second limitation was accessibility of the buoys to Guam's local, recreational-fishing, "mosquito" fleet. Since there are no local large-scale, commercial operations fishing in Guam waters, no buoys were placed more than 3 miles from shore or on the windward side of the island where there are no launching facilities.

Five sites were selected, such that at least two buoys were within range of fishermen leaving from any of the three major launching ramps (Merizo Pier, Apra Harbor and Agana Boat Basin). The southern buoys were anchored in 600 fathoms off of Cocos Island and in 570 fathoms off of Facpi Point. The northern buoys were anchored in 170 fathoms off of Ritidian Point, in 400 fathoms off of Haputo Point and in 500 fathoms off of Camel Rock (Figure 3).

The Cocos Buoy, designated FAD-H, was deployed along with the Facpi Point FAD-A on 18-5-81. The Camel Rock FAD-K was deployed 16-7-81 and the Haputo Point FAD-J was deployed 17-7-81. The Northern site, off of Ritidian Point, was not utilized. As of the end of this fiscal year, FAD A, K and J are still on site. FAD-H appears to have sunk, having been dragged under by its mooring block as it slipped down the bottom incline to deeper water. The last sighting reported that just the mast was above water, however its believed to still be in place and working, although below water.

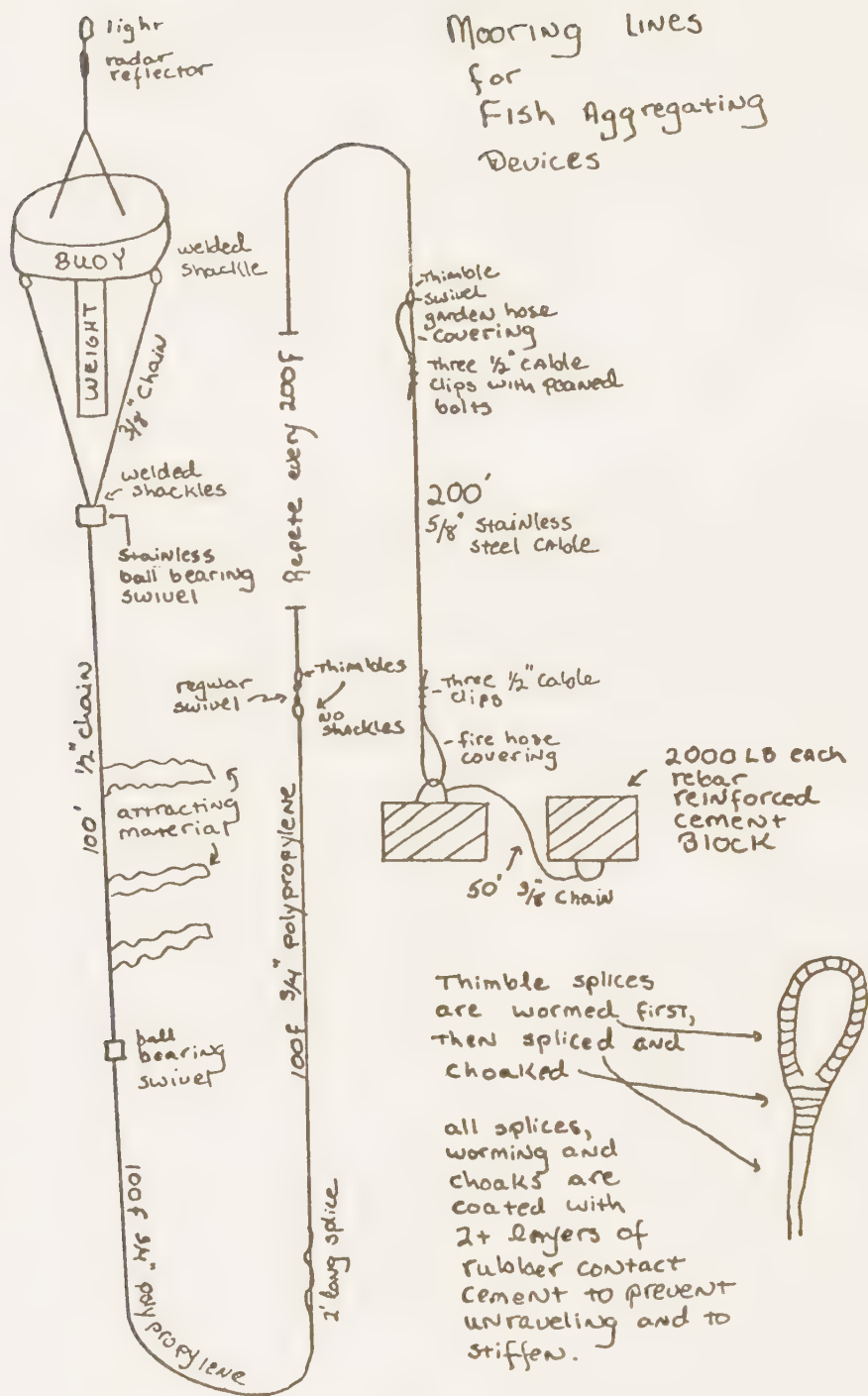


Figure 1. FAD Type-3 mooring line and construction design. Total length of mooring line is determined by multiplying depth by 1.13.

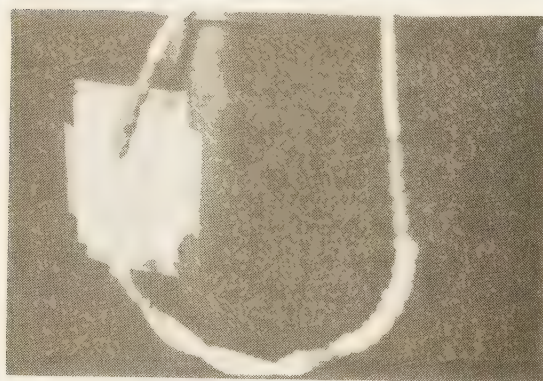
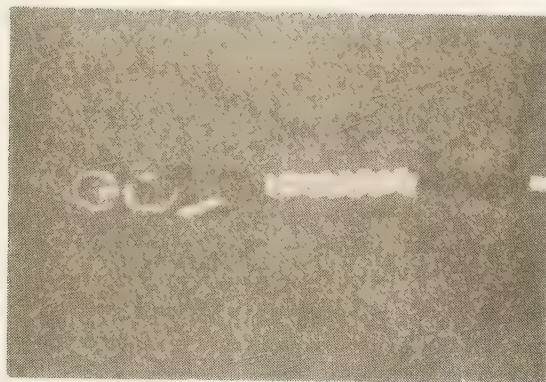


Figure 2. Splices used for mooring line, before coating with rubber contact cement and FAD about to be deployed.

Table 1. Cost breakdown for one Type 3 FAD, based on simultaneously constructing 4 buoys.

CONSTRUCTION

Buoy & Anchor	-----	1,620.00
Foam	-----	406.95
3/8" chain 30'	-----	120.00
Bearing swivels #2	-----	363.58
1/2" chain 100'	-----	611.00
1/2" swivels #4	-----	44.58
35f cable	-----	9.40
3/4" poly 6x30.6kg	-----	601.84
Cable clips #12	-----	16.08
Dacron wipping	-----	17.55
epoxy	-----	2.70
contact cement	-----	3.78
3/4" thimbles #6	-----	11.25
1/2" shackles #6	-----	19.08
light	-----	52.60

3,900.39

DEPLOYMENT

Trucking	-----	71.28
Loading	-----	61.45
Deploying	-----	500.00

632.73

TOTAL ----- \$4,533.12

Data on buoy performance is being collected in three ways. First, and potentially most informative, is by providing stamped fish-buoy (Figure 4) cards at the tackle shops, the Guam Fishermen's Cooperative and to individual fishermen. These were first made available in August, 1981. Second, questions about the FAD are included as part of our regular offshore creel census program at Agana Boat Basin and Merizo Pier. Third, in order to expand on the data obtainable from outside sources, Division of Aquatic and Wildlife Resources personnel conducted fish counts and experimental fishing trips in the area of the FAD. Thirteen dives and three troll-fishing trips have been made at Facpi FAD-A, eight dives and four fishing trips were made at Camel Rock FAD-K and eight dives and three fishing trips have been made at the Haputo Point FAD-J.

FINDINGS

Fishermen cooperation with data gathering is as usual, minimal. Out of the 325 FAD cards distributed, there have been only 6 returns. Reported catches have ranged from none at all after 30 minutes of trolling to 23 wahoo weighing 113.6 Kg after 4 hours. Other catches have included mahimahi and small yellowfin tuna.

Information gathered as part of our regular offshore creel census has been less informative. So far we have no creel census reports of fish catches at the four most recently deployed FAD. To the best of our knowledge only three fishermen have attempted fishing the buoy using a non-troll technique.

Through conversations with fishermen, we do know that there have been catches of wahoo, mahimahi, yellowfin and skipjack tunas, shark and marlin. The three fishermen mentioned above are beginning to use the buoy as a source of "opelu" live bait. Squid, and the jacks (Caranx sexfaciatus) and (Decapterus pinnulatus) have been caught, but only squid have been caught in large quantities. There are large numbers of jacks but they are difficult to catch with a jig. No one has tried a net.

Fish counts using scuba, and experimental fishing trips conducted by the Division of Aquatic and Wildlife Resources are so far the most informative. Although DAWR fishing effort is in its initial stages, trolling, casting while tied to the buoy, and drop rock with fresh bait have been tried. Three small mahimahi, less than 0.5 kg and with empty stomachs, were caught while trolling near the Facpi Point FAD. No other fish have been caught. That no fish are being caught is surprising, since small schools of mahimahi, and individual wahoo, can usually be seen beneath the buoys upon entering the water.

Twenty fish species have been observed associated with the FAD. Seven of these were juveniles or young adult reef species, and five were pelagic bait fish types. Seven were predators, which included 4 species of troll fish. The two species, Canthidermis maculatus and an Antennaridae, are considered as others. (Table 2).

Based on 4 months of observations on Type 3 FAD A, J and K, Caranx sexfaciatus and Decapterus pinnulatus are the first to aggregate. As many as 50 fish were recorded within four hours of deployment and over 1500 by the next day. Reef fish juveniles and young adults were observed within a few days

TO HELP US IMPROVE THE FISH BUOY SYSTEM,
PLEASE FILL OUT THIS INFORMATION FORM
PER BUOY FISHED AS COMPLETELY AS POSSIBLE.

FISH BUOY CARD

DATE: (Month/Day/Year)	No. of Persons Fishing:
BUOY: (Location)	No. of Hrs. Fished at Buoy: (& What Time)
BOAT: (Name & Number)	Method & No. of Lines:

DISTANCE FISHED FROM BUOY:
(Example: Aku caught 100 yds. south of Buoy)

	NO.	TOTAL WT.		NO.	TOTAL WT.
SKIPJACK TUNA			RAINBOW RUNNER		
YELLOWFIN			ATULAI		
MAHIMAH			OTHER		
WAHOO			Please check () here if shark problems		
MARLIN			Please check () here if no catch		
NO. OF BIRD FLOCKS WITHIN 3 MI. OF BUOY:	NO. OF BIRDS PER FLOCK:		NO. & KINDS OF BOATS OBSERVED AT BUOY:		

ADDITIONAL COMMENTS OR SUGGESTIONS: (Types of birds, whales, baltfish, etc.)



AQUATIC AND WILDLIFE RESOURCES
Dept. of Agriculture
P. O. Box 23367
GMF, Guam 96921

Figure 4. Self addressed and stamped FAD catch report card distributed to tackle shops, dive shops and the fisherman's cooperative.

TABLE 2. Fish species seen on FAD; Facpi (A), Camel Rock (K) and Haputo Point (J). These species are divided into reef fish species (R), baitfish types (B), troll species predators (T), other predators (P) and others (O). Species are further classified according to FAD association patterns as small home range regulars (shr), large home range regulars (lhr), irregulars (ir) and refugees (rf). These categories are explained in the text.

Buoy A		
<u>Scarus venosus</u> (R,rf)		
<u>Aspidontus taeniatus</u> (R,rf)		
<u>Monocanthidae sp.1</u> (R,rf)		
<u>Monocanthidae sp.2</u> (R,rf)		
<u>Kyphosus cinerascens</u> (R,rf)		
<u>Aulostomus chinensis</u> (R,rf)		
<u>Exocoetidae</u> (B,ir)		
<u>Decapterus pinnulatus</u> (B,lhr)		
<u>Caranx sexfaciatus</u> (B,shr)		
<u>Psenes cyanophrys</u> (B,shr)		
<u>Coryphaena hippurus</u> (T,lhr)		
<u>Acanthocybium solandri</u> (T,ir)		
<u>Elagatis bipinnulatus</u> (T,lhr)		
Buoy J		
<u>Monocanthidae sp.1</u> (R,rf)		
<u>Kyphosus cinerascens</u> (R,rf)		
<u>Aulostomus chinensis</u> (R,rf)		
<u>Decapterus pinnulatus</u> (B,lhr)		
<u>Caranx sexfaciatus</u> (B,shr)		
<u>Psenes cyanophrys</u> (B,shr)		
<u>Hemiramphidae sp.</u> (B,ir)		
<u>Selar crumenophthalmus</u> (B,ir)		
<u>Coryphaena hippurus</u> (T,lhr)		
<u>Acanthocybium solandri</u> (T,ir)		
<u>Elagatis bipinnulatus</u> (T,lhr)		
<u>Canthidermis maculatus</u> (O,shr)		
<u>Antennariidae sp.</u> (O,shr)		
Buoy K		
<u>Mullidae sp.</u> (R,rf)		
<u>Monocanthidae sp.1</u> (R,rf)		
<u>Kyphosus cinerascens</u> (R,rf)		
<u>Decapterus pinnulatus</u> (B,lhr)		
<u>Caranx sexfaciatus</u> (B,shr)		
<u>Psenes cyanophrys</u> (B,shr)		
<u>Selar crumenophthalmus</u> (B,ir)		
<u>Coryphaena hippurus</u> (T,lhr)		
<u>Elagatis bipinnulatus</u> (T,lhr)		
<u>Carcharias melanopterus</u> (P,lhr)		
<u>Ablennes hians</u> (P,ir)		
<u>Antennariidae sp.</u> (O,shr)		

of deployment but seldom after two weeks. Mahimahi have been observed within as few as 15 days after deployment but usually not before 40 days. Wahoo began to appear after 35 days. Yellowfin tuna were seen after 4 months on one buoy and there have been reports of skipjack tuna schools near the buoy after three months.

The abundance of baitfish species, on FAD A, J and K reached 1530, 470 and 3300 individuals, respectively, within seven days of deployment. Subsequent to these levels, abundance varied from as high as 3010, 2510, and 3330, respectively, to as low as 90, 110 and 260 individuals, respectively. Predator species were observed irregularly. When observed, mahimahi usually numbered at least 3, but as many as 17 have been seen on a single dive. A yellowfin tuna school that came to feed on D. pinnulatus during an evening dive, numbered at least 50, and probably several 100. Wahoo were always solitary and rainbow runners usually numbered two or less.

Four categories of species-FAD association patterns are becoming apparent. "Regulars", which are defined as those species that frequent the buoy consistently, are divided into two categories by home range. C. sexfaciatus is a small home range regular. They are seen in abundance on every dive, and they are always close to the buoy or feeding around it within 50 to 100 meters. D. pinnulatus are considered large home range regulars because they were usually not immediately seen when a diver entered the water, but rather would come in from a distance. Mahimahi, rainbow runner and shark are also in this latter category. "Irregulars" do not exhibit a prolonged FAD association and include Exocoetidae, wahoo and yellowfin and skipjack tuna. The reef fish species are classified as "refugees". Their appearance as initial associates may be related to the lower initial densities of C. sexfaciatus. C. sexfaciatus tend to harass young reef fish and drive them away from the buoy. The classification of other species not mentioned here are indicated in Table 2.

Clearly, it is difficult to determine if a school of fish seen on one day is the same as that of subsequent sightings. If we allow the assumption that they are, it is possible to estimate the residency of some of the baitfish associated with a FAD. This was possible for three species. C. sexfaciatus are perpetual "regulars". D. pinnulatus schools associated with FAD for periods of 10 to 30 days. Selar crumenophthalmus associated for only about 7 days.

There is an apparent diurnal rhythm with respect to the baitfish populations associated with the FAD. At sunrise, large composite schools of D. pinnulatus, C. sexfaciatus, and occasionally S. crumenophthalmus, can be seen milling about the buoy in an apparently docile state. Approximately 7 to 15% of the D. pinnulatus individuals exhibit body wounds. As the sun rises the D. pinnulatus and S. crumenophthalmus move away. The subschools that are seen at mid-day have very few wounds. C. sexfaciatus disperse some distance from the buoy but seldom more than 50 m. The percentage of wounded individuals is constant through the day and seldom exceeds 1 to 4%. At twilight the D. pinnulatus subschools begin to collect near the FAD and resume their docile mode. At this time of day as many as 45% of the individuals have body wounds.

Predation, which is assumed to be the cause of the body wounds has been observed twice. One morning, ten mahimahi, 100 meters or so from the FAD, would repeatedly sound to 45 m, swim towards the mooring line and then follow it up. The body coloration of the mahimahi changed to include light blotchy bars near their head. C. sexfaciatus in the area would react by rushing for the mooring line and charging for the surface. On an evening dive, yellowfin tuna were observed to sound and attack D. pinnulatus from below. This resulted in yellowfin flying into the air. When occasional lone wahoo or shark appeared in the area the D. pinnulatus usually reacted by balling up behind the predator (Figure 4) while the C. sexfaciatus tend to concentrate at the buoy.

The mechanism of FAD attraction was discussed with Dr. Richard Brock, biological researcher on the Hawaiian FAD system during his August 1981 visit to Guam. According to Dr. Brock, the most productive buoys in the Hawaiian system are located on the windward sides of islands and in excess of 800 fathoms. Guam's FADS are anchored in less than 800 fathoms and on the leeward side of the island. Dr. Brock compared Guam's FAD System, deployed for three months, as being as developed as a three week old Hawaiian FAD. Dr. Brock observes that the predator abundance, eg. yellowfin and skipjack tuna, at a Hawaiian FAD are far too great to be fueled only by the baitfish associated with the FAD. Gut analyses of tunas caught near FAD show a high percentage of shrimp. Consequently, it is unlikely that baitfish is the sole attraction for the predators. More likely is the presence of the structure, particularly the mooring line, which provides a visual reference. The attracting material on the mooring line is insignificant in his opinion.

Guam's FAD are not attracting the large quantities of fish comparable to those in the Hawaiian system. Mahimahi seem to be the most regular predators on the FAD, rather than yellowfin and skipjack tuna as is the case in Hawaii. The baitfish schools in the vicinity of Guam FAD do appear to be substantial enough to support the low numbers of mahimahi seen. The observed increase in the size ranges of D. pinnulatus and Caranx sexfaciatus may be because recruitment of young is steady, while those that are surviving at the FAD are growing. Numbers of individuals of both species vary, partly because of constant predation. This assumption is based on the large number of scarred fish and predator activity that are observed. For mahimahi at least, FAD association may be due to prey availability as well as a response to the visual reference. All attracting material was lost from each of the buoys during the August storms. This loss has had no apparent effect on the numbers of baitfish or predators observed on the buoys.

RECOMMENDATIONS

Although the dramatic results recorded from the Hawaiian System have not been observed on Guam, this project will be continued under D-J funds for another year. Two buoys and sufficient line have been kept in reserve for replacements or new sites. It is hoped that the Navy will allow buoy placement at several deeper sites. We will continue to pursue fishermen catch information, spend more time experimenting with non-troll fishing techniques, make more dawn and dusk dives and start transecting the FAD vicinity with a depth recorder. The results have been encouraging so far, and seem to indicate that the likelihood of attracting yellowfin and skipjack schools is good.

Aquaculture
(Public Law 88-309 Matching Funds)

PROJECT TITLE: Development of Tropical Polyculture Fish Farming

PERIOD COVERED: October 1, 1980 through September 30, 1981

FUNDING SOURCE: National Marine Fisheries Service (Public Law 88-309)
Government of Guam

SUMMARY

The Division of Aquatic and Wildlife Resources continued work with the development of aquaculture on Guam during FY 81. Technical assistance and information were provided to people involved in aquaculture; comments were prepared on the Aquaculture Development Plan for the Territory of Guam and Aquaculture - A Program for the Eighties, for the U.S. Department of Agriculture.

A project to develop the culture methodology for the Thai catfish, Pangasius sutchi, was initiated. Due to Typhoon Betty in October, 1980, the existing fish rearing facility had to be repaired. A new fish rearing facility to assist us in our aquaculture program, is scheduled for completion in November, 1981.

Extension Program

Our extension work for 1981 was limited because the University of Guam, College of Agriculture and Life Sciences has assumed this responsibility. A majority of the people who came to the DAWR were interested in culturing hybrid tilapia and had only a casual interest in aquaculture (Table 1). Most wanted to discuss aquaculture development and/or needed technical assistance. The DAWR continued to support the Guam Aquaculture Association, that we established last year, by giving technical assistance and attending monthly meetings. The DAWR staff always remains available to provide any needed technical assistance to the aquaculture industry on Guam.

Development of Culture Methodology for Thai Catfish, Pangasius sutchi

BACKGROUND

The Thai catfish, Pangasius sutchi, is considered to be an excellent food fish and is well adapted for aquaculture use as demonstrated by it's popularity in Thailand. A stock of catfish were given to the Government of Guam by Thailand in November, 1975 and since then have been in a cement holding tanks. Thai personnel have used injections of pituitary glands extracted from wild catfish, and human chorionic gonadotropin to initiate the release of mature eggs from females captured in the wild (Potaros and Sitasit, 1976; Boonbrahm, 1968; Harvey and Hoar, 1979). However to our knowledge, no one has attempted to initiate oogenesis through hormone injections. This procedure is required as no wild, female catfish are available on Guam from which to obtain mature eggs, for subsequent fertilization and reproduction.

TABLE 1. People given technical aquaculture assistance from October 1, 1980 to September 30, 1981.

NAME	LOCATION	INTEREST
Homer T. Cortes	Barrigada	Catfish
Greg T. Perez	Yona	Prawns
Dick Chang	Taiwan	Prawns & Shrimp
David Guisti	Malojloj	Tilapia
Michael Shih Lin	Tamuning	Tilapia
James L. & Brigida S. Dacanay	Dededo	Tilapia
John Lin	Tamuning	Tilapia
Joe Baza	Merizo	Prawn
Martirez A. Payba	Agana	Loan Officer-FmHA
Barbara Zimmerman	Dededo	Backyard
Julia Torrie	Yigo	Tilapia
Teodosio Rodolfo	Yigo	Tilapia
Joseph D. Santos	Dededo	Tilapia
Bob Carson	Yona	Catfish
Pete Quitugua	Ordot	Tilapia
Fred Anglen	Maina	Catfish & Tilapia
Julia Fahriga	Yigo	Tilapia & Guppies
Flora Aguon	Agat	Tilapia & Guppies
Fred P. Camacho	Inarajan	Tilapia
Donald I. Weakley	Inarajan	Tilapia
Joe Perez	Mangilao	Tilapia
Fred Mendiola	Talofofo	Prawn
Miguel Quitugua	Talofofo	Prawn
Peter Wang	Talofofo	Eel

OBJECTIVES

1. To induce oogenesis and egg release in the Thai catfish.
2. To develop the hatchery procedures for rearing the Thai catfish from egg to fingerling stage.

PROCEDURE

Three fish were placed in a subdivided tank (1.4m x 1.5m x .76m) with a flow-through system. The fish were fed a local, 28% protein, fish food, supplemented with ground tuna. To date, two hormone preparations have been used in attempts to initiate oogenesis. They are, carp pituitary by HydroQuest International Corporation and human chorionic gonadotropin (HCG) prepared by Crescent Research Chemicals Inc. Each of the two hormones were given at three dosages based on the body weight of the fish. Injections of the carp pituitary and human chorionic gonadotropin have been given to separate test fish at dosages of 5.5 mg/kg, 2.75mg/kg, 1.39 mg/kg, and 440 IU/Kg, 220 IU/Kg and 110 IU/Kg, respectively. Three replicate fish were injected for each dosage, which was given twice a week. A lcc tuberculin syringe has been used with a 27 gage needle for the HCG and to prevent clogging a 22 gage needle was used for the carp pituitary.

RESULTS

Mature eggs did not result from injections of either hormone. Four fish injected with doses of 5.5 mg/kg and 2.75 mg/kg of carp pituitary have died of an unknown cause. Large numbers of immature eggs have been observed by dissection. Eggs average about one millimeter in diameter and have shown a very slight increase in size over the six week testing period. No development has occurred after attempted fertilization with milt.

RECOMMENDATION

Increasing the frequency of injections or the dosage per injection, and injecting with various carp pituitary and HCG combinations, and salmon pituitary, are being considered as alternative test procedures to obtain complete egg maturation.

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Report prepared by: Wayne Kruckenberg

GUAM WILDLIFE INVESTIGATIONS
PROJECT FW-2R-18
Federal Aid in Wildlife Restoration Act

STATE: Territory of Guam

PROJECT NO.: FW-2R-18

SUB-PROJECT NO.: W-1

STUDY NO.: 1

JOB NO.: 1

JOB TITLE: Determination of Current Population Size and Distribution of Guam Deer.

SUMMARY

Hunting license sales declined slightly this year. An estimated 57 deer were taken during the season. The Northwest Field (NWF) and Naval Communication Area Master Station (NCS) were the most popular hunting areas. Analysis of spotlight count data indicated a non-significant decrease in deer numbers at Andersen Air Force Base (AAFB) and a non-significant increase on Naval Magazine (NAVMAG).

BACKGROUND

The Guam deer has been under investigation by the Division of Aquatic & Wildlife Resources since 1961. Its distribution, population trends and biology have been described by Wheeler (1979). Deer hunting statistics have been compiled since 1968 through hunter reporting procedures.

OBJECTIVES

To determine the current size and distribution of the population of deer on Guam and to monitor population trends.

PROCEDURES

1. Continue monthly spotlight counts on Naval Magazine and Andersen Air Force Base, with periodic spotlight counts in other areas.
 - a. Record number, age, sex and group composition.
 - b. Statistically analyze count data and compare with past data to discern population trends.
2. Investigate the feasibility of using additional census methods, such as pellet group counts, to refine population estimates and knowledge of distribution.
 - a. Conduct surveys and censuses in areas such as the Bolanos Conservation Area, where spotlight counts are not feasible.
 - b. Attempt to correlate spotlight count data with actual deer abundance on AAFB by determining the change in sex ratio after buck-only special hunts.
 - c. Attempt to determine a pellet group index that may be used to estimate deer abundance and/or habitat utilization.

3. Collect hunting statistics by requiring hunters to return hunter report cards. Analyze these statistics for changes in hunter kill, hunter effort and kill locations.

RESULTS

Deer Hunting Statistics

Hunting license sales for all game species declined slightly by 2% from FY 1980 to a total of 333 licensed hunters. Hunting was restricted to antlered deer only, with a season bag limit of one (1) animal.

Thirty-five hunters returned their report cards (10.5% return), and of these, 21 indicated that they had hunted deer (Table 1). Six deer were reported taken by these hunters in the following areas: NWF (3), NCS (1), Uruno (1) and Anao (1) (Table 2). Estimates based on report cards indicated that 200 hunters participated in the hunting season and that 57 deer were taken. These figures are similar to island-wide harvest estimates for previous years (AWR 1979, 1980). More than half of the hunters who returned their report cards indicated that they had hunted on NWF or NCS, making these military lands the most popular areas in which to hunt deer. Hunter logs were maintained throughout the season at these military installations and hunters were required to sign in and out and report any game taken. The combined number of sorties made by gun and bow hunters were nearly equal for both bases (Table 3). A total of six deer were reported taken at NWF and two at NCS. Of non-military areas, the Bolanos Conservation Reserve had the greatest reported number of hunters (Table 2). Limited access due to bad roads and poorly demarcated boundaries were probably the major reasons for discouraging more hunters from using Bolanos and other territorial conservation areas.

Table 1. Island-wide deer hunting statistics, Fiscal Year 1981.

a. Total license sales for all game species	333
b. Number of Hunter Report Cards returned	35
c. Percent of Hunter Report Cards returned	10.5%
d. Number of reporting hunters who hunted deer	21
e. Percent of reporting hunters who hunted deer	60.0%
f. Number of deer taken by 21 hunters	6
g. Hunter success $((fx100)/a)$	28.6%
h. Estimated total number of legal deer hunters (axe)	200
i. Estimated total legal deer take (gxh)	57
j. Number of 8-hour hunter days expended by 21 reporting deer hunters	130
k. Average number of 8-hour hunting days spent per reporting deer hunter (j/d)	6.2
l. Estimated total number of deer hunter days (hxx)	1240
m. Number of 8-hour hunter days per deer taken (j/f)	21.7

Table 2. Island-wide distribution of deer hunting pressure based upon report cards returned by 21 hunters, Fiscal Year 1981.

Hunting Locations	Number Of Hunters	Number Of Hunter Hours	Number Of Deer Taken
NWF	12	657	3
NCS	9	234	1
AAFB	2	72	
Uruno	1	30	1
Bolanos	3	16	
Anao	1	12	1
Astumbo	1	10	
Others	2	9	

Table 3. Hunter effort and deer take based on official hunter logs from NCS and Fiscal Year 1981.

	NCS				NWF			
	# Gun Sorties	# Bow Sorties	Deer Take		# Gun Sorties	# Bow Sorties	Deer Take	
			Gun	Bow			Gun	Bow
October	308	25	1	-	239	5	2	-
November	192	9	1	-	262	12	3	-
December	200	13	-	-	203	2	1	-
TOTAL	747		2		723		6	
Total Hunter-hours	Not Recorded				2828			
Total Hunter-Days	Not Recorded				354			

Spotlight Count Trends

Monthly spotlight count data at AAFB (Table 4) and NAVMAG (Table 5) were analyzed and compared with the previous year by using the Mann-Whitney U-Test (Table 6) (Sokal and Rohlf 1969). The FY 1981 count data from AAFB were lower but not significantly different from the FY 1980 data. The AAFB deer population in the census area may have finally leveled off after 3 years of increases following the cessation of special hunts in June 1978 (AWR 1979, 1980).

Table 4. Composition of deer herd during spotlight counts at Andersen Air Force Base, FY 1981.

	1980			1981									TOTAL	AVE. NO./ COUNT	ST. DEVIATION	
	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP				
Unclassed Buck Spike 2 PT 3 PT 4 PT	4	Count not Conducted	Count not Conducted		1		1	3			3	4	16	7.4	2.72	
	2					2	1		1		3	2	18			
				4			1					2	2			9
	5					3	2	3	3	1	3	5	3			3
Doe Yearling Fawn Unclassed Deer TOTAL	26			19	21	24	29	27	25	35	32	23	261	26.1	4.89	
	5			2		2	3	1	1	2	1		17	1.7	1.49	
	6			3	3	2	2	4	2	3	5		30	3.0	1.70	
	9			5	12	18	3	7	5	15	4	15	93	9.3	5.36	
	57			34	44	57	43	45	37	66	53	45	475	47.5	9.50	
Miles Traveled	4.8			4.7	4.7	4.7	8.6	4.7	4.6	4.7	4.5	4.2	50.2	5.0	1.27	
Deer/10 Miles	118.8			72.3	93.6	108.5	50.0	95.7	80.4	140.4	117.8	107.1	984.6	98.5	26.06	

Table 5. Composition of deer herd and number of carabao seen during spotlight counts at Naval Magazine, FY 1982.

	1980			1981									AVE. NO./ COUNT	ST. DEVIATION	
	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP			TOTAL
Unclassed Buck			Count not Conducted	1	1	1	1	1	2			1	8	3.0	1.89
	Spike	2		2									5		
	2 PT	1											5		
	3 PT	1		3	3	1	1	1	1		2		12		
	4 PT														
Doe	5			14	14	20	14	7	10	12	2	11	109	10.9	5.20
Yearling				3	3	2	4		1		1	1	15	1.5	1.43
Fawn	3			3	4	6	2	2	1	2	1	2	26	2.6	1.50
Unclassed Deer	2			16	12	3	6	5	8	8	2	9	71	7.1	4.51
TOTAL	13			41	39	36	29	16	23	22	8	24	251	25.1	11.14
Miles Traveled	13.9			13.7	13.4	13.3	13.3	13.3	14.2	13.4	13.6	12.6	134.7	13.5	0.43
Deer/10 Miles	9.4			29.9	29.1	27.1	21.8	12.0	16.2	16.4	5.9	19.0	18.6	18.6	8.30
Carabao FY 81	60			10	16	24	43	29	13	27	93	54	369	36.9	25.97
Carabao FY 80	44	9	114	47	11	4	25	30	69	59	49	6	397	33.1	22.09

Table 6. Comparison of deer spotlight counts at Andersen Air Force Base and Naval Magazine between Fiscal Years 1980 and 1981. Significant differences between years were determined with the Mann-Whitney U-Test.

	AAFB		NAVMAG	
	FY 80	FY 81	FY 80	FY 81
No. Counts	12	10	12	10
Maximum No. of Deer Observed/Count	80	66	32	41
Mean No. of Deer Observed/Count	55.1	47.5	16.0	25.1
Std. Deviation	+17.54	+9.50	+6.98	+11.14
Coefficient of Variation (%)	31.8	20.0	43.6	44.4
Significant Difference	NS		NS	

The NAVMAG deer count data from FY 1980 and FY 1981 were not significantly different. However, the mean number of deer seen per count was substantially higher (57% increase) in FY 1981. Heavy poaching pressure, which is probably the major cause for the depressed size of the deer population at NAVMAG, may have declined during FY 1981.

Spotlight counts are not a sensitive indicator of deer population levels and substantial changes in population level must occur before significant changes will be detected. Manpower shortages in FY 1981 have precluded the possibility of intensified sampling with additional spotlight counts as recommended in the previous report.

Feral Asiatic Water Buffalo

Water buffalo (carabao) were observed during all of the deer spotlight counts at NAVMAG in FY 1981. The mean number sighted was 36.1 and the maximum number sighted in one night was 91 (Table 5). Comparative figures from FY 1980 were a mean of 33.1 animals per count and a maximum of 69. These data further confirm the increasing trend in water buffalo number at NAVMAG (AWR 1979, 1980).

RECOMMENDATIONS

Increase the effort directed at determining deer populations in areas other than AAFB and NAVMAG. Further explore the application of pellet group counts and other methods as indices of deer abundance.

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Report prepared by Gary J. Wiles.



Guam deer, a popular game animal.

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-18
SUB-PROJECT NO.: W-1
STUDY NO.: 2
JOB NO.: 1

JOB TITLE: Preparation of a Status Report on Wild Pigs

PERIOD COVERED: October 1, 1980 to September 30, 1981

OBJECTIVES

To prepare a status report on wild pigs to be used in planning future work.

RESULTS

This job was inactive during this segment due to shortage of staff.

RECOMMENDATIONS

This job should be implemented in Segment 19 if adequate manpower is available.

Report prepared by Robert D. Anderson

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-18

SUB-PROJECT.: W-1

STUDY NO.: 2

JOB NO.: 2

JOB TITLE: Population Size and Distribution of Wild Pigs on Guam

PERIOD COVERED: October 1, 1980 to September 30, 1981

SUMMARY

An estimated 219 pig hunters took an estimated total of 266 animals. Northwest Field (NWF) and Naval Communication Area Master Station (NCS) were the most popular hunting areas.

BACKGROUND

The wild pig (Sus scrofa) is one of Guam's two game mammals. The wild pigs on Guam descend from stock introduced by the Spanish during their 300-year role on the island. Wild pigs are found island-wide, though appear to be most numerous in the limestone forests of the north and the ravine forests of southern Guam.

Fieldwork on pigs in the past has been concentrated on military lands. There is a need to assess pig populations in other areas of the island, particularly in the south, where pigs may be under-harvested and where crop damage by pigs is a common complaint.

OBJECTIVES

To determine current population size and distribution and to monitor trends.

PROCEDURES

1. Record pig sightings during deer spotlight counts, and observations of pigs or pig sign during other fieldwork.
2. Conduct surveys using sign counts, flushing counts, on other methods, to determine the relative abundance of pigs in the Bolanos Conservation Area.
3. Monitor the harvest of pigs during the legal hunting season.

RESULTS

Hunter Reports and Harvest Data

Hunting season for wild pigs ran from October through December, with a season bag limit of ten (10) animals. The estimated total number of pig hunters decreased substantially in FY 1981, with 65.7% of the hunters who returned their report cards indicating that they hunted pigs (Table 1). Fifty-two percent of these hunters were successful with an average take of 2.33 pigs each during the season. The estimated total legal pig harvest was 266. These figures represent large increases over FY 1980 (AWR 1980). An estimated 219 pig hunters spent an average of 5.6 eight-hour days hunting pigs.

More than half of the hunters who returned their report cards indicated that they had hunted on NWF or NCS, making these military lands the most popular areas for pig hunting (Table 2). Hunter logs were maintained at each military installation and hunters were required to sign in and out and report any game taken. The combined number of sorties made by gun and bow hunters were nearly equal for both bases (Table 3). A total of 35 pigs were harvested at NWF and 23 at NCS. Of non-military lands, the Bolanos Conservation Area had the greatest reported number of hunters (Table 2).

In spotlight counts for deer made at NAVMAG and AAFB in FY 1981, only three pigs were observed at NAVMAG. Because of behavioral characteristics of pigs and the dense nature of their preferred habitat, spotlight counts are not a good means of assessing numbers and another method must be developed. Because of manpower shortages, no effort was made to determine the size of the pig population in the Bolanos Conservation Area or in other interior areas where access is limited.

Table 1. Island-wide pig hunting statistics for FY 1981.

a.	Total license sales for all game species	333
b.	Number of hunter report cards returned	35
c.	Percent of hunter report cards returned	10.5%
d.	Number of reporting hunters who hunted pigs	23
e.	Percent of reporting hunters who hunted pigs	65.7%
f.	Number of successful pig hunters	12
g.	Percent of reporting hunters who took pigs	52.2%
h.	Number of pigs taken by 23 hunters	28
i.	Average number of pigs taken per successful hunter ($h \div f$)	2.33
j.	Estimated total number of legal pig hunters ($a \times e$)	219
k.	Estimated total legal pig take ($h \times j \div a$)	266
l.	Number of 8-hour hunter days expended by 23 reporting pig hunters	156.5
m.	Average number of 8-hour days spent hunting per reporting pig hunter	6.8
n.	Estimated total number of pig hunter days ($i \times m$)	1490
o.	Number of pig hunter days per pig taken ($l \div h$)	5.6

Table 2. Island-wide distribution of pig hunting pressure based upon report cards returned by 23 hunters for FY 1981.

Hunting Locations	Number of Hunters	Number of Hunter-Hours	Number of Pigs Taken
NWF	13	823	18
NCS	11	301	5
AAFB	2	43	0
Tarzan	1	41	3
Bolanos	3	16	1
Anao	1	12	0
Astumbo	1	10	1
Other	1	6	0

Table 3. Hunter effort and pig take based on Official Hunter Logs from Naval Communication Area Master Station (NCS) and Northwest Field (NWF) in FY 1981.

	NCS			NWF		
	No. Gun Sorties	No. Bow Sorties	Pig Take	No. Gun Sorties	No. Bow Sorties	Pig Take
			Gun Bow			Gun Bow
October	308	25	8 2	239	5	10 -
November	192	9	9 -	262	12	12 -
December	200	13	4 -	203	2	13 -
Total	747		23	723		35
Total Hunter-Hours	Not Recorded			2828		
Total Hunter-Days	Not Recorded			354		

RECOMMENDATIONS

Continue to monitor hunting seasons and the harvest of pigs. As manpower becomes available, increase management and research activities, particularly in southern non-military areas.

LITERATURE CITED

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Report prepared by: Gary Wiles



Guam Wild Pig

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-18

SUB-PROJECT NO.: W-2

STUDY NO.: 1

JOB NO.: 1

JOB TITLE: Preparation of a Status Report on Philippine Turtle Doves

PERIOD COVERED: October 1, 1980 to September 30, 1981

OBJECTIVES

To prepare a status report on Philippine turtle doves for use in planning future work.

RESULTS

This job was inactive during this segment due to shortage of staff.

RECOMMENDATIONS

This job should be implemented in Segment 19 if adequate manpower is available.

Report prepared by: Robert Anderson

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-R-18
SUB-PROJECT NO.: W-2
STUDY NO.: 1
JOB NO.: 2

JOB TITLE: Population Numbers and Distribution of Philippine Turtle Doves

PERIOD COVERED: October 1, 1980 to September 30, 1981

SUMMARY

Roadside counts indicate that Northwest Field (NWF) has the highest Philippine turtle dove population of the three areas censused, followed by the North-Central Route. No statistically significant changes in population levels were indicated in FY 1981.

BACKGROUND

Until recently, the Philippine turtle dove (Streptopelia bitorquata) was the only game bird on Guam. It was introduced by the Spanish about 1771 from the Philippines (Baker, 1951). The Philippine turtle dove has been a regulated game bird since the first hunting season was established in 1965. The current hunting season is July 1 to July 31, with a daily limit of four birds and a season limit of twenty. Although considerable work has been done in the past on nesting and movement of Philippine turtle doves (Drahos, 1977) current effort is restricted to roadside counts and monitoring of hunter harvest.

OBJECTIVE

To determine present population levels and distribution and monitor trends.

PROCEDURES

1. Continue bi-weekly roadside counts in three locations in northern Guam.
2. Begin roadside counts or call counts in other areas to determine distribution and relative abundance.
3. Monitor hunter harvest during legal season.

RESULTS

Roadside Counts

The Northwest Field (NWF) area continues to have the highest populations of Philippine turtle doves of the three areas censused by roadside count. Roadside count data from FY 1980 and FY 1981 were compared using the Mann-Whitney U-Test. Results of the roadside counts and the U-Test analysis are presented in Tables 1-3 and Table 5 of W-4-1-3.

Although not statistically significant, sizeable increases in the number of birds observed per 100 miles of travel were found on the Northwest Field and North Central route.

Hunter Harvest

The 1980 Philippine turtle dove hunting season was July 1 - July 31, with a daily limit of four and a season limit of twenty birds. Table 1 presents the results of the hunter report card survey; only five of the thirty-five hunters who returned this report card reported that they had hunted doves. The estimated total number of dove hunters was 48, with an estimated total harvest of 684 birds. This figure is subject to much bias because of the low report card return rate and the fact that successful hunters are most likely to return their cards.

Table 1. Island-wide Philippine turtle dove hunting statistics.

a.	License sales:	333
b.	No. hunter reports returned:	35
c.	Percent returned ($b/a \times 100$):	10.5%
d.	No. reporting hunters who hunted doves:	5
e.	Percent of reporting hunters who hunted doves ($d/b \times 100$):	14.3%
f.	No. successful dove hunters:	4
g.	Percent reporting dove hunters who took doves ($f/d \times 100$):	80%
h.	No. doves taken by 4 hunters:	57
i.	Average No. doves per successful hunter (h/f):	14.25
j.	Estimated total No. legal dove hunters ($a \times e$):	48
k.	Estimated total No. legal doves taken ($a \times e \times i$):	684
l.	No. 8 hr. days expended by 6 reporting dove hunters:	15
m.	Average No. days each hunter spent:	2.5
n.	Estimated total No. dove hunter days ($j \times m$):	120
o.	No. dove hunter days per dove taken (n/k):	.18

RECOMMENDATIONS

1. Continue bi-weekly roadside counts in three locations in northern Guam and begin additional roadside counts or call counts in other areas to monitor distribution and relative abundance of Philippine turtle doves.
2. Continue to monitor hunter harvest and adjust hunting seasons and bag limits to provide for sustained yield management of dove populations.

LITERATURE CITED

- Baker, R. H. 1951. The avifauna of Micronesia, its origin evolution, and distribution. University of Kansas Pub. 3(1):1-359.
- Drahos, N. 1977. The Doves of Guam. Unpublished manuscript. Division of Aquatic and Wildlife Resources.

Report prepared by Robert D. Anderson



The Philippine turtle dove is a popular game bird.

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-18

SUB-PROJECT NO.: W-2

STUDY NO.: 2

JOB NO.: 2

JOB TITLE: Population Size and Distribution of Black Francolin on Guam

PERIOD COVERED: October 1, 1980 to September 30, 1981

SUMMARY

Bi-monthly fixed distance circular-plot censuses were conducted along 3 transect routes in southern savannah habitat on Guam.

Density estimates of calling males and comparisons with 1980 data were shown. Seasonal and time-dependant changes in calling frequency and calling intervals were documented. An experimental hunt was held during two weekends in December 1980. Based on high population estimates, a month-long hunt in December 1981 was recommended.

BACKGROUND

As part of the Foreign Game Bird Introduction Program of the U.S. Fish and Wildlife Service, our Division investigated the possibility of introducing game birds to Guam for local harvest. One hundred and seventy-one black francolins were released in the Cross-Island Road area of southern Guam in 1961. Given ideal habitat, these birds slowly prospered and sporadic observations by local farmers and Division biologists documented their success.

Black francolins were monitored and trapped at Orote Point peninsula and Talofofo/Inarajan from 1968 to 1973 (Drahos 1977). Censusing was discontinued until 1980 when plans were developed to systematically survey southern Guam to determine black francolin abundance, density and distribution and make recommendations for a possible hunting season.

Nine transects were located in areas of prime savannah habitat in southern Guam. A total of 366 counts were conducted from April through June, 1980, both early morning and at dusk. Francolin were found to be well distributed in southern Guam, with an estimated total population of nearly 5000 birds (DAWR 1980). After a public meeting, special black francolin hunting regulations were issued and an experimental hunting season was held during two weekends in December, 1980. Censusing along 3 key transects in southern Guam during 1981 continued to indicate any changes in population numbers and further document calling frequency and seasonality.

OBJECTIVES

To determine current distribution and relative abundance of black francolin on Guam and to make recommendations for hunting seasons and bag limits.

PROCEDURES

Bi-monthly surveys of black francolin were conducted along three transect routes in southern Guam (Figure 1). An average of 34 stations was censused monthly using fixed distance circular-plot methods (Emlen 1971). Transects were censused both early morning and at dusk to determine the most effective censusing time. The number of calling males heard or seen within 200 yds (26 acres) of the observer were recorded, along with any females or broods. The number of calls per minute were also recorded to document calling frequency. Density estimates based upon the mean number of calling males per station (26 acres) and the assumption of one female per calling male, were compared with 1980 data over the same time period to test for significant changes in population numbers.

A two-weekend experimental hunting season was held in December, 1980. Three hunter check stations were manned by Division biologists and conservation officers to collect biological data.

RESULTS

Data from three transects in southern Guam are presented in Table 1. Talofoto and Pulantat showed similar mean density estimates of 0.94 and 1.01 calling males per station, respectively. Merizo, the southern most transect, showed an average of 0.80 calling males per station, a significant drop ($P < .05$) from 1980 figures (Table 2). No significant difference in population size was indicated between years along the Talofoto and Pulantat transects.

All transects showed high numbers of calling males from January through July, with calling dropping off in August and ceasing entirely in October. Calling began to increase in November, perhaps indicating almost year-round breeding on Guam, a departure from the normal March to October breeding season in their native India (Bump 1964).

Table 3 shows changes in calling intervals through time and indicates the most active calling periods. Males on the average called every 15 seconds from 6:00 to 8:00 a.m., with calling intervals increasing as the mornings wore on. A non-significant decrease in calling interval was recorded between 9:00 and 10:00 a.m. Calling increased in intensity from 5:00 p.m. until dark, when all calling ceased. It was decided to conduct future censuses from 6:00 to 8:00 a.m. when calling intensity would be the most predictable.

HUNTER HARVEST

An experimental black francolin hunt was held during the weekends of December 6 and 7, and 13 and 14, 1980. Check stations were manned by Division personnel each weekend at Dandan, Cross Island Road and Merizo from 9:00 a.m. to 12:00 noon and from 4:00 p.m. to 7:00 p.m. to record hunter success and collect biological data.

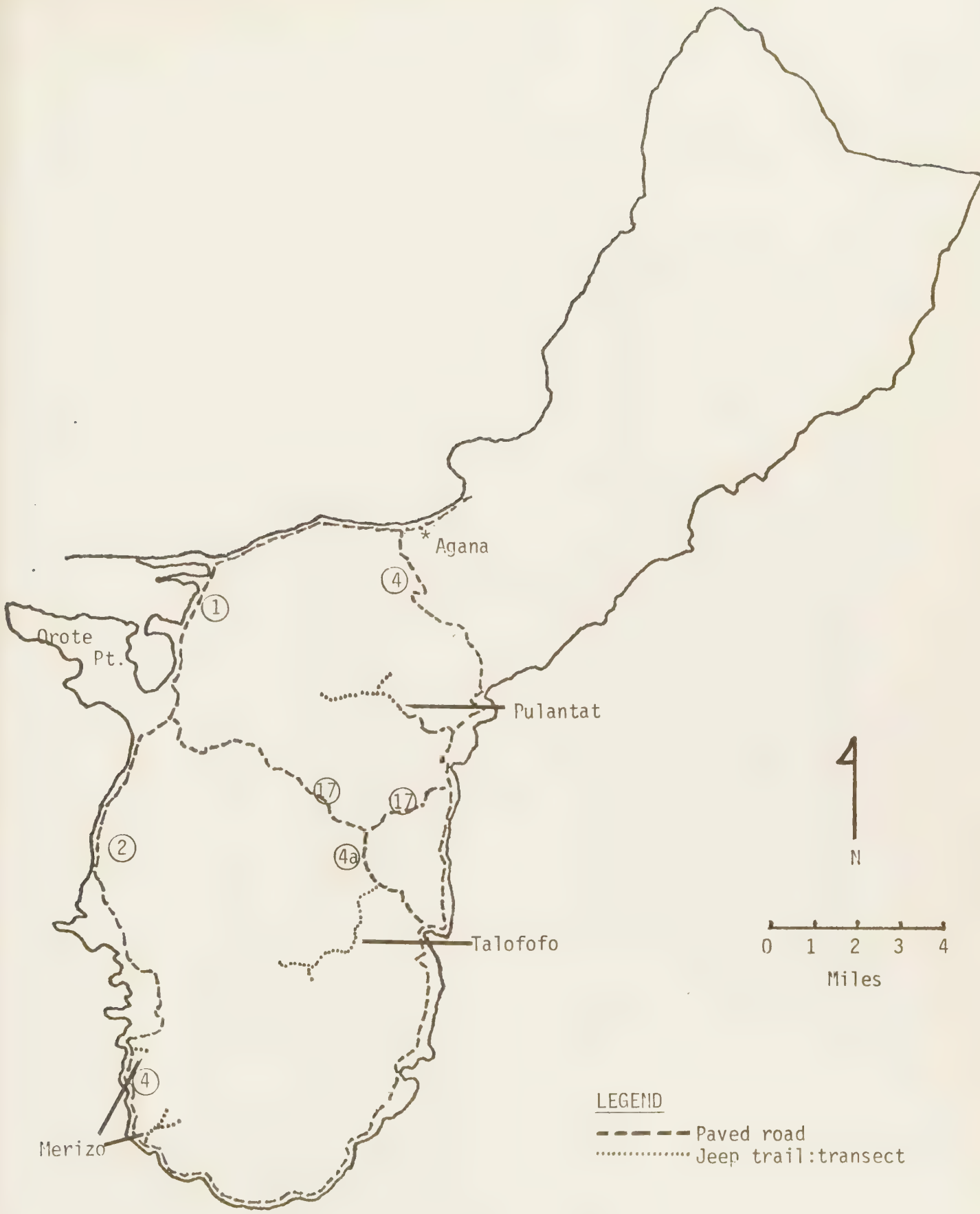


Figure 1. Black francolin transect routes in southern Guam

Table 1. Results of censusing black francolins during FY 1981 with fixed distance circular-plots. Shows mean number of calling males per station from three target transect areas.

AREA	1980												1981
	OCT.	NOV.	DEC.	JAN.	FEB.	MARCH	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	TOTAL
PULANTAT													
# of Surveys	2	2	2	2	2	2	1	1	2	2	1	2	21
# of Counts	15	19	18	18	18	18	9	10	20	20	10	20	195
$\bar{x}$ calling males per station	0.0	0.42	0.28	1.67	1.56	1.33	0.89	0.60	1.75	1.80	0.90	0.90	1.01
TALOFOFO													
# of Surveys	1	2	2	1	no data	2	2	1	2	2	2	2	19
# of Counts	11	34	29	15	no data	31	36	18	36	36	36	36	318
$\bar{x}$ calling males per station	0.0	1.53	0.76	1.00		0.90	1.42	1.06	1.83	1.13	0.55	0.19	0.94
MERIZO													
# of Surveys	2	2	2	2	1		1	1	1	2	1	2	17
# of Counts	22	22	22	24	11	no data	11	12	12	24	12	23	195
$\bar{x}$ calling males per station	0.0	0.77	0.68	0.92	1.54		1.00	0.83	1.13	1.13	0.0	0.74	0.80

Table 2. Results of black francolin fixed distance circular-plot censuses conducted during April, May, June, August and September of FY 1980 and FY 1981 over three transects in southern Guam. Shows mean number of calling males per station, standard deviation (δ) and coefficient of variation (CV). Asterisks indicate means significantly different ($P < .05$) from the preceding year as determined by the Mann-Whitney U-test.

AREA	April		May		June		Aug.		Sept.		# Counts		$\bar{x}$		δ		CV	
	1980	1981	1980	1981	1980	1981	1980	1981	1980	1981	1980	1981	1980	1981	1980	1981	1980	1981
Pulantat	1.50	0.89	1.50	0.60	1.64	1.75	0.60	0.90	0.10	0.90	67	69	1.07	1.01	0.68	0.43	137.40	43.08
Talofofo	1.11	1.42	1.89	1.06	1.59	1.83	1.00	0.55	0.00	0.19	88	162	1.12	1.01	0.72	0.66	64.54	65.06
Merizo	1.18	1.00	1.64	0.83	1.63	1.13	1.73	0.00	1.06	0.74	88	94	1.45	0.74*	0.30	0.44	21.06	59.50
Combined Transects	1.26	1.10	1.68	0.83	1.62	1.57	1.11	0.48	0.39	0.61	243	325	1.21	0.92	0.52	0.44	42.75	48.49

Table 3. Mean calling intervals of male black francolins on three transects in southern Guam during FY 1981. Asterisk indicates a mean significantly different ($P < .05$) from the preceding time as determined by the Mann-Whitney U-test.

Time of Day	$\bar{x}$ calling interval	# males calling
am		
6:00 - 6:59	14.67 sec.	53
7:00 - 7:59	14.79 sec.	43
8:00 - 8:59	18.90 sec.	209
9:00 - 9:59	15.27 sec.	145
10:00 - 10:59	19.52 sec.	48
pm		
5:00 - 5:59	19.62 sec.	76
6:00 - 6:59	14.81 sec. *	77
7:00 - 7:59	13.60 sec.	5

A total of 8 hunters reported in at check stations (Table 4). Three hunters had been successful with a total of 6 francolins bagged. Successful hunters all used dogs to flush birds from the tall swordgrass. Additional individuals may have participated in the hunt in areas far-removed from checking stations or at times when the stations were unmanned. In the future, stationary checking stations will be discontinued in favor of spot-checks in the field by roving biologists and conservation officers throughout the hunting season. Increased public awareness and an extended hunting season should increase hunter participation as well as the number birds harvested.

Table 4. Black francolin hunt data for 1980 collected at official checking stations in southern Guam.

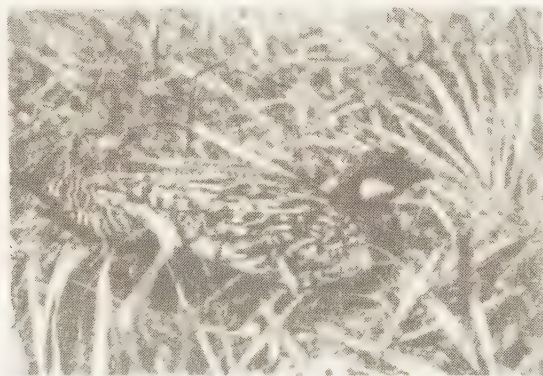
AREA	No. Hunters	No. Success	Male Birds		Female Birds		Total Birds
			Juv.	Adult	Juv.	Adult	
Dandan	7	2	1	2	1	1	5
Cross-Island	1	1	0	1	0	0	1

It was decided to recommend another black francolin hunt in December of 1981. The season will probably be increased to include the entire month of December and the season limit increased to 20 birds, with a bag limit of four francolins per day. Should the black francolin population show that it can withstand an increased harvest, the general hunting regulations may be amended to include an annual black francolin hunting season.

RECOMMENDATIONS

1. Continue monthly surveys of black francolins along 3 transect routes.
2. Establish an annual black francolin hunting season.
3. Collect and compile data on age and sex ratios from birds examined during spot-checks of hunters throughout the 1981 black francolin hunting season.

Report prepared by: Anne F. Maben



Black Francolin
-124-

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-18

SUB-PROJECT NO.: W-4

STUDY NO.: 1

JOB NO.: 1

JOB TITLE: Survey and Inventory of Shorebirds on Guam

PERIOD COVERED: October 1, 1980 to September 30, 1981

SUMMARY

Bi-monthly shorebird censuses were conducted on two coastal transects and 20 species from the families Ardeidae, Haematopodidae, Charadriidae, Scolopacidae and Laridae were recorded. Periodic surveys of grassland areas were also conducted. One migrant shorebird previously unreported from the Marianas was recorded.

Two papers on species composition and abundance of shorebirds on Guam by Division biologists were accepted for publication.

BACKGROUND

Migratory shorebirds make up a significant proportion of birds present on Guam. Prior to 1978, observations consisted of intermittent sight records and the collection of museum skins by visiting ornithologists.

In 1978, research was initiated to systematically quantify species composition and seasonality on Guam. Baseline data was gathered from 100 counts conducted along two coastal transects and compiled for publication (Jenkins 1981).

Bi-monthly counts along these same transects have continued to be conducted to monitor any significant fluctuations in species composition and abundance and compile new observations on shorebird activity.

OBJECTIVE

To continue to inventory shorebirds on Guam and monitor their periodic occurrences.

PROCEDURES

1. Bi-monthly censuses were conducted along the shoreline of Agana Bay (Alupang Cove) and along the shoreline of Togcha beach (Figure 1) from January through October 1981. Data were not obtained during May and June of 1981. Species numbers and composition of all migrant shorebirds were recorded along with pertinent behavioral observations.

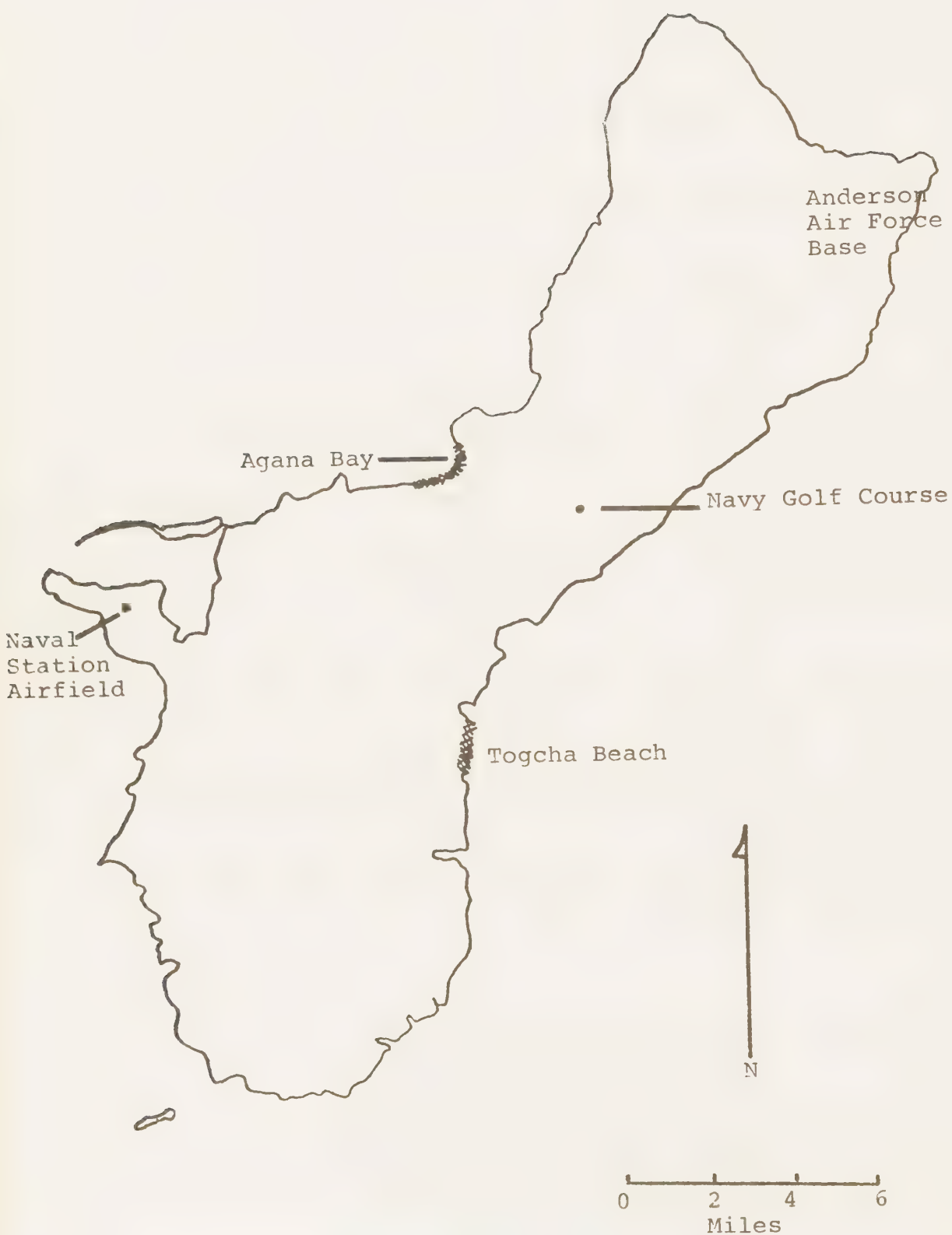


Figure 1. Shorebird transects and major shorebird grassland areas on Guam.

Surveys of shorebirds on grassland areas were conducted by conservation officers during bimonthly roadside bird counts and periodically on golf courses and airfields by Division biologists.

2. Baseline data by former Division biologist J. Mark Jenkins were compiled into a manuscript entitled "Seasonality and relative abundance of Guam shorebirds" and was accepted for publication (Jenkins 1981). Also published was a paper "Nine new bird records for Guam and Rota" (Maben and Wiles 1981) which included 2 new shorebirds observed on transect study sites.

RESULTS

Data from the shorebird censuses conducted during 1981 are presented in Tables 1 and 2, expressed as the number of birds of each species observed per 100 kilometers of travel each month. These data were compared with data from similar months in 1980 and tested for significant differences in population numbers using the MannWhitney Utest (Sokal and Rohlf 1969).

As in previous years, these tables illustrate a high stability between years of migrant shorebird populations on Guam. While significant increases ($P < .05$) in little ringed plover, common greenshank and common sandpiper populations were noted along the Togcha beach transect, these numbers simply reflect the presence of a few birds where none were noted in previous years. However, the Mongolian Dotterel increase at rocky Togcha beach, represents a four-fold increase over 1980 and may reflect a change in foraging substrate preference. This species showed a non-significant 27% decrease in birds per 100 kilometers along the sandy, more protected reef flats of Agana Bay. Significant decreases ($P < .05$) in bar-tailed godwits at Agana Bay and sanderlings at Togcha Beach represent populations of birds far small to make long-term conclusions.

A two-fold decrease in whimbrel populations was recorded along Agana Bay. The curlew population on Agana Bay showed a non-significant increase of 226 birds per 100 kilometers and may be forcing whimbrels to forage in more marginal habitats. A single individual terek sandpiper (*Tringa cinerea*), was observed at Togcha beach on October 13, 1981 and represents the first recording for this species in the Marianas.

Periodic surveys of grasslands and airfields indicate that plovers and sandpipers aggregate in groups of 300-500 just before and after migration. Data gathered since 1978 indicate the majority of Pacific golden plovers leave Guam during the 2nd and 3rd weeks of April and return to the island by the 3rd week in August. Shorebirds tend to spread out evenly during the winter months and are totally absent from inland areas during June and July (DAWR field notes). The small numbers of presumably immature shorebirds over-summering on Guam are found strictly along coastal regions.

Table 4 in the W4-4-1-3 (Native Birds) Job Progress Report show no significant change in golden plover numbers on any of the roadside counts. The mean number of plovers per 100 km on combined 1980 coastal transects shows population numbers three times greater than the mean number of plovers per 100 miles observed along the north-central roadside count route (containing the most grasslands).

RECOMMENDATIONS

1. Discontinue bi-monthly censuses as data has documented the relative stability and species composition of shorebird populations on Guam.

Table 1. Number of birds per 100 kilometers of travel observed each month during the Aana Bay shorebird surveys, during January through October, 1981. Shows mean number of birds per hundred kilometers of travel, standard deviation (σ), and coefficient of variation (CV). Asterisks indicate means significantly lower ($P < .05$) from the preceeding year as determined by the Mann-Whitney U-test. Data were not collected for the months of May and June.

SPECIES	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Total	X/Count	X/100 km	σ	CV
Reef Heron	58.8	58.8	29.4	19.6			29.4	0	58.8	29.4	10	0.6	35.5	21.6	60.8
European Oystercatcher	58.8	58.8	58.8	58.8			0	0	0	0	9	0.5	29.4	31.4	100.8
Black-bellied Plover	29.4	58.8	117.6	0			0	29.4	29.4	0	9	0.5	33.1	39.9	120.5
Golden Plover	500	10735.2	8617.6	13607.8			2058.8	6500	852.9	1794.1	1750	102.9	5583.3	5014	89.8
Little Ringed Plover	0	29.4	88.2	39.2			0	29.4	58.8	88.2	12	0.7	41.7	34.6	82.9
Mongolian Dotterel	205.8	117.6	235.2	137.2			29.4	147.0	235.2	205.9	47	2.8	164.2	70.6	43.0
Ruddy Turnstone	29.4	382.3	294.1	882.3			1441.1	911.7	88.2	58.2	154	9.1	510.9	513	100.4
Whimbrel	58.8	117.6	235.2	392.1			88.2	588.2	264.7	264.7	75	4.4	251.2*	175.4	69.8
Bristle-thighed Curlew	117.6	323.5	470.5	352.9			1117.6	88.2	205.8	294.1	73	4.3	246.3	136.1	55.3
Bar-tailed Godwit	0	0	29.4	19.6			0	0	0	0	2	0.1	6.1	11.6	190.2
Common Greenshank	0	0	0	0			0	0	0	0	0	0	0	0	0
Wood Sandpiper	0	0	0	0			0	0	0	0	0	0	0	0	0
Terek Sandpiper	0	0	0	0			0	0	0	0	0	0	0	0	0
Common Sandpiper	29.4	147.0	205.8	215.6			0	0	58.8	58.8	28	1.6	89.4	88.0	98.4
Tattlers	588.2	588.2	676.4	1176.4			1000	647	588.2	500	216	12.7	720.6	237.4	33.0
Sanderling	58.8	29.4	0	39.2			0	0	0	29.4	6	0.4	19.6	22.8	116.3
Sharp-tailed Sandpiper	0	0	0	0			0	0	0	29.4	1	0.1	3.7	10.4	281.1
Rufous-necked Stint	0	0	970.5	549			0	0	0	147.1	66	3.9	208.3	362.1	173.8
Little Tern	0	58.8	29.4	19.6			0	58.8	29.4	0	7	0.4	24.5	24.6	100.4
Kilometers	3.4	3.4	3.4	5.1			3.4	3.4	3.4	3.4	28.9	1.7			
Counts	2	2	2	3			2	2	2	2	17				

Table 2. Number of birds per 100 kilometers of travel observed each month during the Togcha Beach shorebird surveys, during January through October, 1981. Shows mean number of birds per hundred miles of travel, standard deviation (σ) and coefficient of variation (CV). Asterisks indicate means significantly lower ($P < .05$) from the preceding year and pluses indicate means significantly higher ($P < .05$) from the preceding year as determined by the Mann-Whitney U-test. Data were not collected for the months of May and June.

SPECIES	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Total	X/Count	X/100 Km	σ	CV
Reef Heron	96.1	96.2	57.6	57.6			38.4	19.2	96.2	134.6	31	1.9	74.5	37.7	50.6
European Oystercatcher	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Black-bellied Plover	57.6	38.4	38.4	19.2			0	19.2	0	0	9	0.6	21.6	21.6	100.0
Golden Plover	1423	1211.5	1576.9	826.9			115.3	865.3	1615.4	961.5	447	27.9	1074.5	496.1	46.2
Little Ringed Plover	0	0	0	0			0	19.2	19.2	0	2	0.1	4.8+	8.9	185.2
Mongolian Dotterel	882.3	346.2	288.4	250			96.1	211.5	288.5	365.4	141	8.8	341.1+	234.3	68.7
Ruddy Turnstone	76.9	0	289.2	461.5			288.4	288.4	557.7	384.6	119	7.4	290.8	185.2	63.7
Whimbrels and Curlews	19.2	19.2	38.4	19.2			0	57.6	134.6	115.3	21	1.3			
Bar-tailed Godwit	0	0	0	0			0	0	0	0	0	0	0*	0	0
Common Greenshank	0	0	0	0			0	19.2	38.4	0	3	0.2	7.2+	14.3	198.4
Wood Sandpiper	38.5	38.5	0	0			0	0	0	0	4	0.3	6.2	13.3	215.2
Terek Sandpiper	0	0	0	0			0	0	0	19.2	1	0.1	2.4	6.8	282.8
Common Sandpiper	0	0	0	0			0	19.2	19.2	0	2	0.1	2.5+	6.7	267.2
Tattlers	423	365.4	250	461.4			211.5	250	307.7	423.1	140	8.8	336.5	94.7	28.2
Sanderling	19.2	38.4	0	0			0	0	0	0	3	0.2	7.2*	14.3	198.4
Sharp-tailed Sandpiper	0	0	0	0			0	0	0	0	0	0	0	0	0
Rufous-necked Stint	750	403.8	19.2	19.2			269.2	365.3	788.5	423.1	158	9.9	378.7	287.7	76.0
Little Tern	0	0	0	0			0	0	0	0	0	0	0	0	0
Kilometers	5.2	5.2	5.2	5.2			5.2	5.2	5.2	5.2	41.6	2.6			
Counts	2	2	2	2			2	2	2	2	16				

2. Continue to record incidental shorebird observations as they occur and document species new to Guam.

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Report prepared by: Anne Maben



The tattler is one of several species of shorebirds found on Guam.

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-18

SUB-PROJECT NO.: W-4

STUDY NO.: 1

JOB NO.: 2

JOB TITLE: Survey and Inventory of Seabirds on Guam

PERIOD COVERED: October 1, 1980 to September 30, 1981

SUMMARY

Breeding sites of seabirds on Guam were periodically surveyed for significant increases or decreases in population. Certain seabird species were also indexed during forest bird roadside and station counts. One seabird new to Guam was recorded. One paper documenting 2 new records of seabirds on Guam in 1980 was accepted for publication.

BACKGROUND

Since seabirds are used as important indicators of fishing grounds by local residents, surveys were initiated to determine any fluctuations in seabird abundance or distribution.

Periodic surveys of resident seabird colonies on Guam have been conducted since the early 1960's. While only four species of seabirds are resident, 40 off-shore surveys conducted by this Division in 1980 recorded the relative abundance, frequency of occurrence and feeding habits of 16 species utilizing the waters surrounding the island, three of which were new records to Guam (DAWR 1980).

Cocos Island supports southern Guam's only sizable white tern population. Since two-thirds of the island is privately owned, the colony may be subjected to adverse habitat disturbance due to increased private development. Plans were made to adequately census the colony to obtain baseline data for any future environmental impact assessments.

OBJECTIVES

To inventory seabirds on Guam and monitor their periodic occurrences.

PROCEDURES

1. Known recorded breeding sites of noddy terns, tropicbirds and brown boobies were visited occasionally for evidence of nesting and to approximate population numbers. White terns were censused at Cocos Island for absolute population numbers and data from roadside counts were used as an index to detect any significant changes in the number of fairy terns observed.
2. Off-shore feeding areas were not visited in 1981, due to a lack of man-power and a decrease in the availability of commercial fishing vessels. Records were maintained of seabird observations gathered sporadically throughout the year.

3. A paper entitled "Nine new bird records for Guam and Rota" (Maben and Wiles, 1981) was accepted for publication and included two species of seabirds previously unrecorded on Guam.

RESULTS

Three species of shearwaters were recorded in waters surrounding Guam in 1981. The light phase of the wedge-tailed shearwater was commonly observed in small numbers by local fishermen throughout the year. Two wedge-tails were recovered by fishermen and brought to this Division in September, apparently exhausted after a storm. Both birds were banded and released successfully. One dead and two injured short-tailed shearwaters were received by Division biologists after heavy storms in May. Fisherman reported many dark shearwaters during a two week period, possibly indicating a large flock forced off course by the storm. Two Manx shearwaters were recovered by the Division in June and July. One of the two survived and was released after 5 days of treatment. Blood samples were obtained from all individuals to determine if they may have carried transmittable avian diseases.

Two immature greater frigatebirds were recovered by the Division in 1981, apparently exhausted from recent storms. Both birds died soon afterwards. Blood samples were obtained, one of which showed a high level of unidentified bacteria. Slides will be further examined off-island for evidence of disease. One female frigatebird was observed feeding off-shore at Cocos Island, presumably a stray from the frigatebird colony on nearby Rota Island.

Brown boobies were recorded three times at Orote Point during 1981 but no evidence of nesting was determined. Two brown boobies were observed resting and feeding at Anae Island, and fishermen reported large flocks commonly feeding at offshore banks. An unusually high proportion of juvenile brown boobies were observed at offshore fishing banks in October and November 1981 by local fisherman John Eads. These sightings may indicate increased breeding success at the large colony on Rota Island as well as on Guam.

A total of five adult tropicbirds were recorded during the highest count at Two Lover's point during 1981. Counts were not conducted at the Two Lover's colony during May and June and the apparent drop in number may simply reflect the dispersal of tropicbirds outside of the breeding season. A total of 16 birds were recorded at Tarague Beach, Haputo, Lafac, Pati and Ritidian Points as well as Fena Lake and Merizo from January to June, 1981. A pair of tropicbirds were observed sitting on an undercut ledge at Tarague beach in February, indicating possible breeding in areas other than Two Lover's Point.

Five species of terns were observed on Guam in 1981. One great crested tern (Sterna bergii), a new record for Guam, was observed foraging near shore at Tarague beach on June 16. A single bird, possibly the same individual, was sighted foraging within the reef flat on August 15 at Rota Island. Although abundant in the lagoons of Palau, Truk and Ponape, this species was formally know in the Marianas only from the northern islands.

Seven little terns were observed during shorebird transects in 1981 (W-4-1-1 shorebirds Job Progress Report). A single bird was also observed foraging on tilapia at Fena Lake in September. First reported on Guam in 1980, this species may now be considered an occasional migrant to the island.

Common terns were also sporadically recorded as accidental migrants in inshore waters throughout the year. An adult in partial breeding plumage was found dead of unknown causes in September and retained by the Division for further analysis.

Nesting noddy terns were recorded at AAFB, Orote Peninsula, Anae Island and several offshore islets in southern Guam (Figure 1). The noddies' major breeding effort commenced the second week in March at Anae Island where over 175 individuals were observed, most of them with eggs or young. The majority of nestlings appeared to have fledged successfully by May 17, 1981 when only eight adults on eggs were observed. Eight noddies were observed gathering nesting materials on Andersen Air Force Base on March 24. Although the majority of breeding records in past years fall in March and April, eggs and young have been reported on Guam for all months of the year (Baker 1951, DAWR Field notes). The noddy colony at Orote Peninsula appeared stable at approximately 50 pairs, although much of the colony was impossible to observe from a stationary vantage point. Noddies at Orote Point may disperse to other areas when not breeding as fewer than 5 birds were observed to breed on off-shore buoys at the mouth of Apra Harbor, where a maximum of four pairs per buoy were recorded.

White (fairy) terns were most abundant from Haputo Point north to Ritidian and east to Tarague beach in 1981 (Figure 1). Few individuals were observed in the Pati Point area which apparently contains suitable habitat. Small colonies of 6 to 12 pairs of white terns continued to be observed at Andersen Air Force Base, Andersen South housing and the Navy Golf Course. This species was seldom observed in the developed central and north-central regions of the island, although studies on Midway Island showed that white terns may readily adapt to human habitation (Howell 1970). Data from Table Job W-4-1-3 show a significant decrease ($P < .05$) in white terns observed during north roadside counts as determined by the Mann-Whitney U-test (Sokal and Rohlf 1969). A mean of 1.8 birds per 100 miles was recorded along this route, down from a mean high of 12.1 per 100 miles in 1977 (DAWR 1977). Data from the Northwest Field and north-central roadside counts show no significant change in fairy tern populations along these routes. Fairy terns appear absent from the dense ravine forest of southern Guam, areas where they were commonly recorded in southern censuses up to 1975 (DAWR 1975). Despite the pressure of increased development, 18 to 20 pairs of white terns were censused on the private sector of Cocos Island in July 1981. Twenty-three pairs of terns were recorded on the public section of Cocos during May. Cocos Island contains the only population of native forest birds (Micronesian starlings) left in southern Guam and may be less severely impacted by the variety of factors influencing the decline of Guam's native birds. Given that the distribution of white terns on Guam generally duplicates the present range of native forest birds in most respects, white terns may also be found to be influenced by the same factors responsible for the forest bird's decline.

RECOMMENDATIONS

1. Discontinue periodic surveys of seabird nesting sites and off-shore feeding areas as data have documented the relative stability of these areas.
2. Continue to monitor the white tern population using data collected on forest bird roadside counts and through censuses conducted on Cocos Island.
3. Continue to record incidental seabird observations as they occur and document species new to Guam.

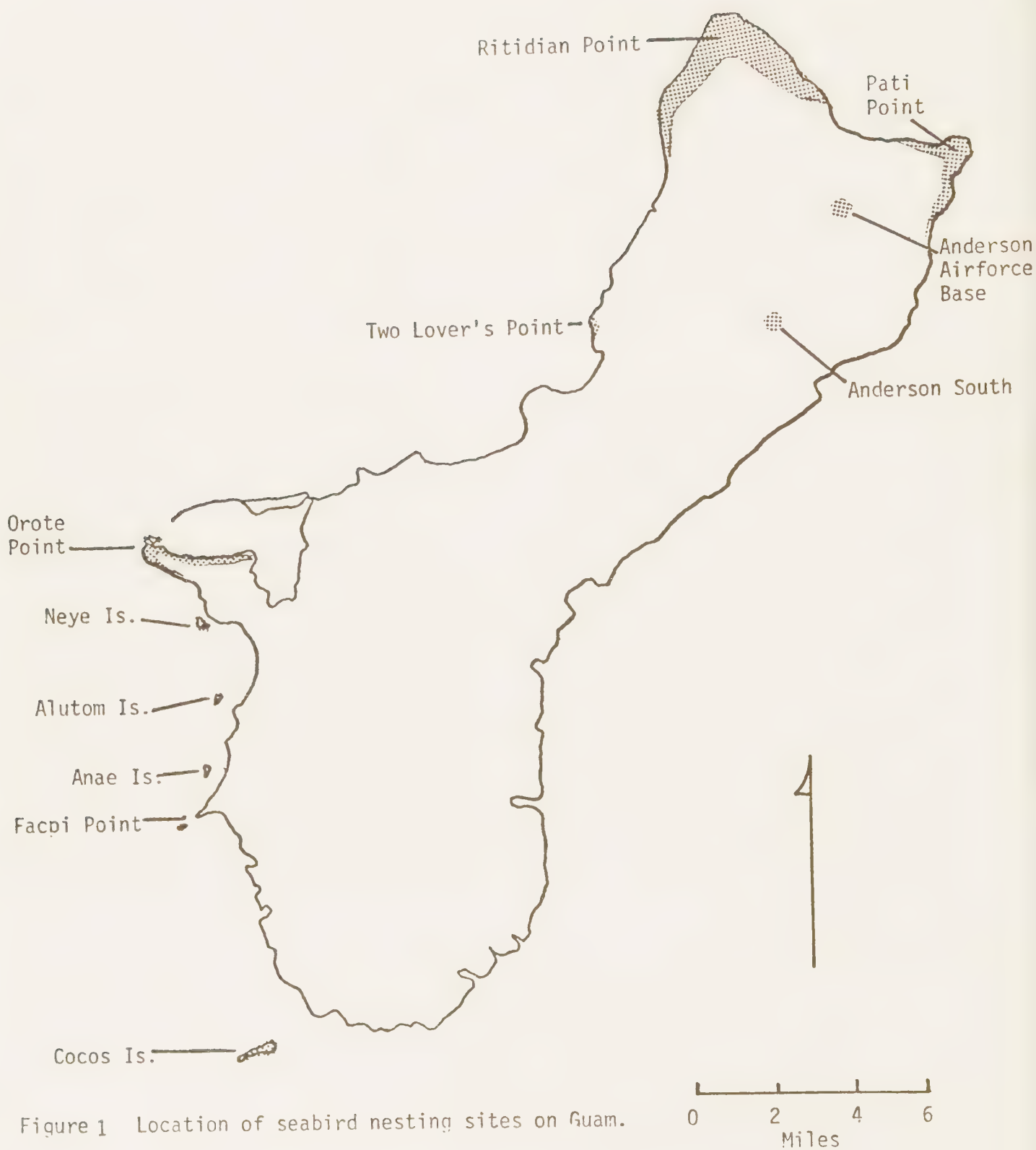
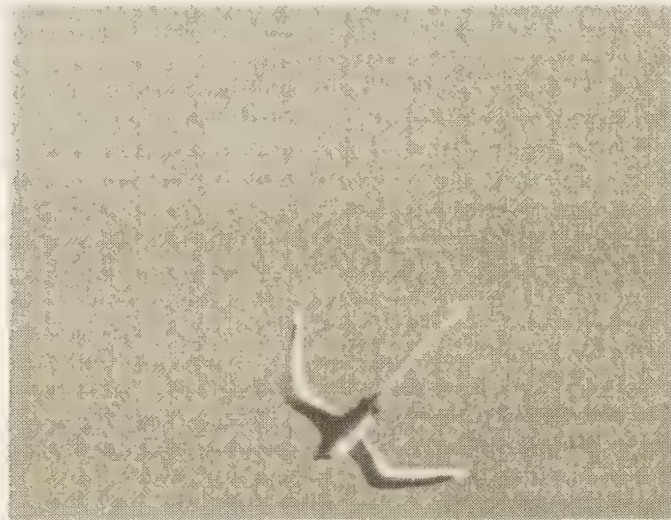


Figure 1 Location of seabird nesting sites on Guam.

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- Howell, Thomas. 1970. Ecology and reproductive behavior of the white, or fairy tern. Nat. Geo. Research Rept: 274-284.
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- Sokal, R.R. and F.J. Rohlf. 1969. Biometry. W. H. Freeman and Co. San Francisco. 776 pp.

Report prepared by: Anne Maben



White-tailed tropicbird, one of Guam's most beautiful seabirds.

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-18
SUB-PROJECT NO.: W-4
STUDY NO.: 1
JOB NO.: 3

JOB TITLE: Survey and Inventory of Native Land Birds on Guam and Northern
Marianas Islands

Period Covered: October 1, 1980 To September 30, 1981

SUMMARY

Of the 12 native birds of Guam presently proposed for inclusion on the U.S. Endangered Species list, six species have recorded declines in population and two species showed no significant changes in population in roadside counts conducted during Fiscal Year 1981 in 3 areas of northern Guam. Four rare bird species were undetected during these counts.

Bird densities and indices of relative abundance were estimated from monthly station counts in 12 areas in northern Guam and compared with similar counts from 1980 to show significant increases or decreases in population numbers. In addition, variable circular-plot censuses were conducted at 234 stations along random transects in both northern and southern Guam in June by the U.S. Fish and Wildlife Service and this Division. Results of these counts and similar counts made on Rota are currently being analyzed.

Mist-netting and banding of native land birds were conducted on a limited scale in conjunction with a blood sampling program.

Two additional native birds were proposed for inclusion on the U.S. Endangered Species list and previously submitted proposals were updated. A local Guam Endangered Species list, including 12 bird species, was established and submitted to the Legislature for approval.

BACKGROUND

Because of significant population declines since the mid-1960's, 12 species of native land birds have been proposed as candidates for the federal Endangered Species list. Factors such as destruction of habitat, pesticide use, predation by introduced predators, and avian diseases may be impacting bird populations. Native birds are now restricted primarily to the northern cliffline limestone forests.

Roadside counts have been conducted since the early 1960's over 3 routes in northern Guam and can be used as general indicators of long range population changes. Density estimates of native birds derived from variable circular-plot censuses have been calculated since 1979 in the few areas where the

forest birds remain. Similar censuses on Rota where birds are abundant have been conducted 4 times since 1979 and provide a basis for comparison. In addition, it was felt that an island-wide circular-plot survey conducted over a short period of time would yield accurate population estimates for the majority of native land birds. Survey methods and sampling design were set up by the U.S. Fish and Wildlife Service and censusing was implemented in June of 1981 with the cooperation of this Division. Plans are currently being developed by the U.S. Fish and Wildlife Service to census select islands in the Northern Marianas in similar intensities to provide accurate population comparisons.

Basic research into the ecology, life history and behavior of native birds continues to be conducted. Such studies are needed to determine population trends and are instrumental in the formulation of recovery programs.

OBJECTIVES

To monitor population trends of the native land birds on Guam and the Northern Mariana Islands.

PROCEDURES

1. Roadside counts were conducted at bi-weekly intervals on three routes in northern Guam (Figure 1). These routes were driven at approximately 10-15 miles per hour beginning at sunrise. Numbers and species of all birds seen or heard were recorded, irrespective of the distance from the observer.
2. Eight minute variable circular-plot censuses (Reynolds et al. 1980) were conducted at ten locations in the northern cliffline area and two locations in the northern plateau forests on Guam (Figure 2). These stations were censused monthly from sunrise to four hours after sunrise. Birds seen or heard were recorded along with the distance at which the birds were observed. The estimated detection area for each species was estimated and used to compute population density estimates using the method described by Reynolds et al. (1980). Population density estimates from all 12 stations were combined to determine average population densities for each species during four quarterly periods. Relative abundance, defined as the number of birds of a species recorded divided by the total number of birds recorded during the same count period, was also determined at each station. Similar counts were conducted at 64 stations on Rota in March and August, 1981 (Figure 3).
3. In conjunction with the U.S. Fish & Wildlife Service, a total of 234 stations in 10 random locations and along 23 random transects were censused in areas of high and low bird density on Guam during June, 1981. Prior to censusing, Division personnel received additional training in distance estimation and species identification to ensure comparable data collection. Transects were randomly located to prevent bias and stations were premarked and placed 150 m apart along the transects to minimize the possibility of observing the same bird from different stations. Stations were



Figure 1. North, North-Central, and Northwest Field Roadside Bird Census Routes.



Figure 2. Ten cliffline and 2 plateau stations in Northern Guam.

ROTA ISLAND



Figure 3. Location of variable circular-plot census stations on Rota Island.

censused using eight minute variable circular-plot counts as described by Reynolds et al. (1980) and data were recorded directly onto computerized sheets for later analysis.

4. Rails were censused at most transect stations and in Andersen South by the use of playback calls. Each station was surveyed for four minutes; taped rail calls were played for one minute followed by one minute of observation without playback; the process was then repeated a second time. Birds observed during the first two minutes were recorded separately from those which were observed during the last two minutes of observation.
5. Marianas crows were censused by simultaneous observation by observers stationed at five overlooks along the northern cliffline .
6. Mist-netting in areas of high bird density was also conducted during 1981. Birds were netted attracted using playback calls and nets were placed along wildlife corridors. All birds encountered were banded, weighed, measured and photographed. Blood samples were taken for use in avian disease studies.

RESULTS

Roadside Counts

Data from the roadside counts conducted during Fiscal Year 1981 are presented in Tables 1-3, expressed as the number of birds of each species observed per 100 miles of travel. Table 4 presents data showing changes between years that were tested for significance using the Mann-Whitney U-Test (Sokal and Rohlf 1969). Examination of these tables in general shows a continuing decline in native bird populations along all 3 routes.

North-Central Route: Slight increases in the populations of 2 native birds were recorded while significant declines ($P < .05$) were observed in 3 native species. Marianas crows and Marianas fruit doves were not recorded along this route during any 1981 counts. Micronesian starling and white-throated ground dove populations remained stable at very low levels.

North Route: Seven native bird populations showed significant decreases ($P < 0.5$), two species of which were not observed on any count in 1981. Although a significant increase in Micronesian kingfishers was indicated, population numbers were still extremely small. All other native birds populations remained low but stable while the introduced Eurasian tree sparrow population showed a significant ($P < .05$) three-fold increase in numbers.

Northwest-Field Route: Although the Northwest Field roadside route has in past years had the highest bird populations, three species of native birds showed significant reduction ($P < .05$) in numbers in 1981. Conversely, the Eurasian tree sparrow showed a significant increase in population numbers. Micronesian starlings were recorded in high numbers and the cardinal honeyeater and Marianas crow populations remained stable and relatively abundant. Guam rail and rufous-fronted fantail populations appeared low but stable.

Table 1. Number of birds per 100 miles of travel observed each month on the Northwest Field roadside count route during FY 1981. No data were collected during January and February 1981.

SPECIES	1980					1981												TOTAL	X/100 MI	FY 1981
	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT								
Wren	13.8	0	9.2			8.7	13.2	13.6	11.7	37.0	18.9	10.8	29		2.0		14.6			
Black Crow	9.2	87.0	37.0			5.8	44.2	13.6	11.7	97.2	141.5	10.8	82		8.2		16.7			
Duck	161.3	674.3	481.4			322.5	703.5	395.4	899.7	504.6	500.0	495.0	1107		110.7		52.8			
Parakeet	0	50.4	0			0	13.2	0	8.8	55.6	66.0	0	36		3.6		1.7			
Fruit Dove	0	0	0			5.8	0	0	2.9	0	0	0	3		0.3		0.9			
Golden Plover	73.7	114.6	212.9			158.3	30.9	54.5	2.9	0	0	39.6	142		14.2		18.7			
Ground Dove	0	4.5	0			2.9	0	0	5.8	46.3	0	0	14		1.4		6.0			
Honeyeater	13.8	68.8	27.7			23.4	13.2	0	88.4	74.1	75.5	0	86		8.6		38.5			
Kingfisher	0	4.5	0			2.9	13.2	0	5.8	27.8	0	0	13		1.3		5.4			
P. T. Dove	161.2	224.7	453.7			114.3	190.2	127.2	941.0	384.2	311.3	326.7	711		71.1		323.5			
Rail	9.2	0	0			8.7	4.4	0	0	0	0	0	6		0.6		2.2			
Rice Bird	0	0	0			35.1	0	22.7	0	0	0	178.2	35		3.5		23.6			
Sparrow	55.2	0	0			46.9	0	0	0	0	0	0	28		2.8		10.2			
Starling	27.6	151.3	101.8			41.0	101.7	5.0	197.6	217.6	301.9	89.1	253		25.3		128.8			
White Tern	0	0	0			8.7	0	0	14.7	68.1	37.7	0	17		1.7		12.9			
Males	21.7	21.8	10.8			34.1	22.6	22.0	33.9	21.6	10.6	10.1	209.2		11.6					
Courts	2	2	1			2	2	2	3	2	1	1	18							

Table 2. Number of birds per 100 miles of travel observed each month on the North roadside count route during FY 1981. No data were collected during February 1981.

SPECIES	1980						1981						TOTAL	X/COUNT	X/ 100 mi
	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT			
Bittern	0	18.3	0	0		2.0	20.0	9.9	2.9	2.2	4.2	0	23	1.2	5.4
Black Crow	0	5.2	0	0		0	0	2.4	0	0	0	0	3	0.2	0.7
Diongo	55.5	109.9	89.9	48.3		56.4	77.3	89.3	77.3	89.5	87.5	17.2	323	17	72.6
Pantail	0	0	0	0		0	0	0	0	0	0	0	0	0	0
Fruit Dove	0	0	0	0		0	0	0	0	4.4	4.2	0	3	0.2	0.8
Golden Plover	205.1	193.7	225.9	187.3		240.5	607.4	7.4	1.4	0	0	137.3	655	34.5	164.2
Ground Dove	0	2.6	0	0		2.0	2.8	0	1.4	0	0	0	4	0.2	0.8
Honeyeater	0	0	0	0		0	2.8	0	0	0	0	0	1	0.1	0.3
Kingfisher	0	5.2	0	0		12.5	5.7	0	5.8	2.2	4.2	0	16	0.8	3.2
P. T. Dove	25.6	5.2	33.4	21.1		29.2	48.7	19.8	33.5	34.9	29.2	21.5	121	6.4	27.4
Rail	0	0	0	0		0	0	0	0	0	0	0	0	0	0
Rice Bird	0	5.2	0	0		0	5.7	22.3	0	0	0	0	11	0.6	3.0
Sparrow	89.7	52.3	50.2	27.1		46.0	77.3	109.1	75.9	67.7	66.7	0	266	14	60.2
Starling	4.2	15.7	6.2	0		47.8	8.5	17.3	14.5	10.9	0	0	45	2.4	11.4
White Tern	0	0	8.3	0		6.2	0	4.9	0	0	0	0	9	0.5	1.8
Miles	23.4	38.2	47.8	33.1		47.8	34.9	40.3	68.5	45.8	24.0	23.3	427.1	22.5	
Counts	1	2	2	1		2	2	2	3	2	1	1	19		

Table 3. Number of birds per 100 miles of travel observed each month on the North-Central roadside count route during FY 1981. No data were collected during January and August of 1981.

SPECIES	1980				1981								TOTAL	Σ/COUNT	Σ/100 mi
	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT			
Eastern	28.1	4.2	20.7		0	33.3	27.3	21.2	13.6	7.6		52.2	38	2.4	20.8
Black Crow	0	0	0		0	0	0	0	0	0		0	0	0	0
Diango	128.5	130.8	207.2		157.0	141.6	72.7	425.5	100	7.6		69.6	211	13.2	144.1
Franklin	0	0	0		0	0	18.2	0	9.0	0		0	4	0.3	2.7
Franklin Dove	0	0	0		0	0	0	0	0	0		0	0	0	0
Golden Plover	831.3	2405.0	1870.4		2512.3	3270.8	0	0	4.5	0		991.3	2342	146.4	1188.6
Ground Dove	0	0	5.1		0	4.1	18.2	12.7	9.0	0		0	9	0.6	4.9
Honeyeater	0	0	15.5		0	4.1	0	0	0	0		0	4	0.3	2.0
Kingfisher	0	0	0		0	0	0	0	13.6	0		0	3	0.2	1.4
P. T. Dove	28.1	88.6	160.6		66.1	79.1	136.4	102.1	104.5	83.3		78.3	168	10.5	92.7
Rail	0	0	0		0	4.1	0	0	0	0		17.4	3	0.2	2.2
Rice Bird	116.4	0	145.0		0	179.1	0	8.5	0	0		26.1	105	6.6	47.5
Sparrow	72.2	63.2	0		33.0	0	136.4	136.1	140.9	68.2		43.5	129	8.1	69.4
Starling	52.2	0	5.1		0	16.6	0	4.2	4.5	0		0	20	1.3	8.3
White Tern	0	0	5.1		0	79.1	36.4	17.0	18.1	0		0	32	2.0	15.6
Niles	24.9	23.7	19.3		12.1	24.0	11.0	23.5	22.0	13.2		11.5	185.2	11.6	
Counts	2	2	2		1	2	1	2	2	1		1	16		

Table 4. Results of the Northwest Field, North, and North-Central showing the mean number of birds per 100 miles of travel, the standard deviation (σ) and the coefficient of variation on (CV). Asterisks indicate means significantly lower ($P < .05$) from the preceding year and pluses indicate means significantly higher ($P < .05$) from the preceding year as determined by the Mann-Whitney U-Test.

Species	Northwest Field FY 1981			North FY 1981			North-Central FY 1981		
	$\bar{X}$	σ	CV	$\bar{X}$	σ	CV	$\bar{X}$	σ	CV
Bittern	14.6	9.6	66.0	5.4	7.4	136.6	20.8	15.5	74.6
Black Crow	46.7	46.4	99.4	0.7*	1.7	240.2	0	0	0
Drongo	513.8	207.4	40.4	72.6	26.0	35.8	144.1	113.0	78.5
Fantail	19.4	26.8	138.3	0*	0	0	2.7+	6.1	225.4
Fruit Dove	0.9*	2.0	225.0	0.8*	1.7	222.6	0*	0	0
Golden Plover	68.7*	72.4	105.4	164.2	177.4	108.1	1188.6	1240.0	104.3
Ground Dove	5.0*	14.3	241.1	0.8*	1.2	145.3	4.9	6.5	131.5
Honeyeater	38.5	34.3	89.2	0.3*	0.8	331.7	2.0+	4.9	251.5
Kingfisher	5.4*	8.9	164.5	3.2+	4.0	122.3	1.4*	4.3	316.2
P.T. Dove	323.5	244.6	75.6	27.4	11.0	40.1	92.7	36.7	39.6
Rail	2.2	3.8	170.4	0*	0	0	2.2*	5.5	256.3
Rice Bird	23.5*	21.6	236.1	3.0	6.8	2.2	47.5	70.6	148.6
Sparrow	10.2*	55.7	211.7	60.2+	30.0	49.8	69.4	53.5	77.1
Starling	128.0	88.4	69.1	11.4	13.7	120.1	8.3	16.3	196.9
White Tern	12.9	22.8	176.5	1.8*	3.1	176.7	15.6	25.4	163.0

Counts conducted on the three established roadside routes necessarily sample bird populations in more disturbed habitat than station counts conducted in relatively pristine areas. Also, roadside counts provide only an index to population levels, whereas station counts provide an estimate of density.

Station Counts

Average densities of eleven native bird species recorded during station counts were determined for each quarterly period (Table 5) and document any seasonal changes in abundance.

Density values determined for each native species at twelve locations in 1981 are presented in Table 6. Tables 7 and 8 include new density values for 1979 and 1980 in the same locations. Original densities presented in DAWR (1980) were revised to conform with more accurate estimates of Detection Area (D.A.) due to a great increase in the number of station counts performed in 1981. Table 9 shows the relative abundance of all birds recorded during station counts at twelve locations on Guam.

An analysis of densities derived from station counts over the last 3 years indicates that bird populations are continuing to decline and that the native bird species are becoming increasingly concentrated in the Northwest portion of the island.

Counts at Tolang and Two Lover's Point have consistently recorded no native birds since 1980. While these locations are closer to main human population centers and may be necessarily more disturbed, the station counts themselves are conducted in areas of prime and 2nd growth limestone forest and have historically contained good bird populations (Baker 1951). Five different species of native birds were recorded at Two Lover's Point in 1979.

Anderson South, an area of significant decline ($P < .05$) in total bird density had 8 different native bird species recorded in 1979. Although the mixture of forest and grassy areas in Andersen South provides perfect habitat for the Guam Rail, this species has shown an almost five-fold decline in rail numbers since 1979.

The Lajuna station count located on the east coast near Andersen South recorded few birds in either 1980 or 1981.

The station count located in pristine habitat at Haputo Point recorded 10 species in 1979, 8 species in 1980 and only 7 species in 1981. No rails, fantails or fruit doves were observed at this location in 1981.

Anao Point, on the northeast coast, consists of habitat so prime it has been designated a conservation reserve. Nevertheless, only 3 native bird species were recorded in 1981, all in extremely low numbers. Kingfishers now appear to be absent from the area although recorded in 1980.

Significant declines ($P < .05$) in total bird densities occurred in 1981 at Pati Point, an area of restricted access and dense forest on the northeast coast. This area sustains the only fruit bat colony of any size on island and all eleven native forest bird species were consistently recorded here in 1979. During seventeen counts at Pati Point in 1981, only 4 different

Table 5. Average population density values (birds/ha) of each species during quarterly periods in FY 1981. Shows Detection Area as described by Reynolds et al. 1980 (D.A. = hectares per station). Asterisks indicate Detection Areas determined from 1980 data as 1981 populations were so low Detection Areas could not be determined.

SPECIES	Oct - Dec.	Jan - Mar	Apr - Jun	Jul - Aug	D.A.
Bittern	0.0	0.02	0.01	0.04	2.63*
Broadbill	0.09	0.03	0.08	0.13	0.58*
Crow	0.24	0.28	0.44	0.33	3.08
Fantail	0.40	0.91	1.26	1.13	0.34
Fruit Dove	0.04	0.11	0.12	0.04	3.27
Ground Dove	0.25	0.64	0.42	0.13	0.20*
Honeyeater	0.65	0.75	0.68	0.55	1.02
Kingfisher	0.13	0.24	0.30	0.05	3.40
Rail	0.62	0.78	0.43	0.36	0.14*
Starling	1.49	2.16	2.00	1.31	1.06
White-eye	0.30	0.23	0.45	0.32	0.16*
No. of counts per location	81	55	84	39	

Table 6. Population density values (birds/ha) of 11 native forest birds recorded in twelve locations on Guam from Fiscal Year 1981. Shows Detection Area as described by Reynolds et al. 1980 (D.A. = ha/station) mean density values per species, the standard deviation (s) and the coefficient of variation (CV). Asterisks indicate means significantly lower (P<.05) from the preceding year as determined by the Mann-Whitney U-Test. (d) indicate Detection Areas determined from 1980 data as 1981 populations were so low detection areas could not be determined.

Location Stations Per Location	Tolang	Anderson* South	Lajuna	Anao	Pati*	Tarague	Northwest Field	Pitidian	Uruno	Haputo	Tanguissan	Two Lovers Point	D.A.	$\bar{X}$ Density	s	CV
	1	3	1	2	2	4	6	2	2	3	1	1				
SPECIES																
Bittern	0.00	0.00	0.00	0.00	0.00	0.02	0.03	0.00	0.00	0.04	0.04	0.00	2.63 ^d	0.01*	0.02	154.75
Broadbill	0.00	0.00	0.00	0.00	0.00	0.00	0.06	1.09	0.00	0.06	0.00	0.00	0.58 ^d	0.10*	0.37	320.14
Crow	0.00	0.00	0.29	0.00	0.46	0.40	0.61	0.48	0.60	0.20	0.00	0.00	3.08	0.25	0.25	98.72
Fantail	0.00	0.00	0.00	0.00	0.00	0.00	2.51	3.25	0.16	0.00	0.00	0.00	0.34	0.49*	1.73	228.11
Fruit Dove	0.00	0.00	0.00	0.00	0.00	0.02	0.21	0.32	0.07	0.00	0.00	0.00	3.27	0.05*	0.10	201.96
Ground Dove	0.00	0.00	0.00	0.00	0.00	0.54	0.09	0.26	1.67	1.07	0.00	0.00	0.20 ^d	0.32	0.52	167.72
Honeyeater	0.00	0.18	0.00	0.05	0.00	0.19	2.50	1.03	0.22	0.44	0.00	0.00	1.20	0.37	6.71	189.33
Kingfisher	0.00	0.00	0.00	0.00	0.16	0.37	0.30	0.28	0.29	0.21	0.07	0.00	3.40	0.14	0.14	100.63
Rail	0.00	0.02	0.00	0.40	0.00	0.00	0.00	0.75	0.00	0.00	0.00	0.00	0.14 ^d	0.46*	1.24	272.10
Starling	0.00	4.34	0.00	0.00	0.00	2.17	2.95	4.52	3.32	1.52	0.00	0.00	1.06	1.33	1.57	117.80
White-eye	0.00	0.03	0.00	0.73	0.72	0.00	0.00	3.95	0.00	0.00	0.00	0.00	0.16 ^d	0.39*	1.11	291.90
No. of Counts per location	10	28	10	18	17	37	55	19	18	28	9	10	Total Counts = 252			

Table 7. Population density values (birds/ha) of 11 native forest birds recorded in eleven locations on Guam from Fiscal Year 1980. Shows Detection Area as described by Reynolds et al. 1980 (D.A. = ha/station) mean density values per species, the standard deviation (~) and the coefficient of variation (CV). Asterisks indicate means significantly lower ($P < 0.05$) from the preceding year as determined by the Mann-Whitney U-Test. D.A. follows 1981 estimates.

Location Stations Per Location	Tolang	Anderson South	Lajuna	Anao	Pati	Taraque	Northwest Field	Ritidian	Uruno	Haputo	Two Lovers Point	D.A.	$\bar{X}$ Density	σ	CV
SPECIES	1	1	1	1	1	1	1	1	1	1	1				
Bittern	0.0	0.04	0.00	0.00	0.00	0.03	0.14	0.00	0.00	0.14	0.0	2.63	0.03	0.06	195.53
Broadbill	0.0	0.00	0.00	0.00	0.63	0.47	0.16	1.88	0.52	0.00	0.0	0.58	0.33	0.57	170.82
Crow	0.0	0.00	0.27	0.27	0.47	0.68	0.38	0.62	0.52	0.44	0.0	3.08	0.33	0.25	74.48
Fantail	0.0	0.00	0.00	0.00	1.87	1.87	0.80	7.22	3.24	0.27	0.0	0.34	1.39	2.22	159.68
Fruit Dove	0.0	0.00	0.00	0.00	0.00	0.06	0.11	0.39	0.40	0.03	0.0	3.27	0.09	0.15	171.99
Ground Dove	0.0	0.56	0.00	0.00	0.91	0.91	0.45	1.36	0.50	5.45	0.0	0.20	0.92	1.57	170.24
Honeyeater	0.0	0.00	0.00	0.00	0.00	0.80	0.80	0.98	0.39	0.18	0.0	1.02	0.29	0.39	136.27
Kingfisher	0.0	0.07	0.00	0.19	0.21	0.32	0.19	0.24	0.32	0.35	0.0	3.40	0.17	0.13	78.13
Rail	0.0	15.87	0.00	2.60	1.95	0.00	0.00	0.00	0.00	0.00	0.0	0.14	1.86*	4.74	255.24
Starling	0.0	0.10	0.09	0.09	2.23	2.83	2.57	3.77	2.55	2.40	0.0	1.06	1.50	1.46	96.98
White-Eye	0.0	0.00	0.00	0.00	4.54	0.00	1.14	12.50	1.25	0.00	0.0	0.16	1.77	3.81	215.88
No. of Counts per Location	10	9	11	11	11	11	11	11	10	11	11	11	Total Counts = 117		

Table 8. Population density values (birds/ha) of 11 native forest birds recorded in eleven locations on Guam from Fiscal Year 1979. Shows Detection Area as described by Reynolds et al. 1980 (D.A. = ha/station), mean density values per species, the standard deviation (s) and the coefficient of variation (CV). D.A. follows 1981 estimates.

Location Stations Per Location	Tolang	Anderson South	Lajuna	Anao	Pati	Tarague	Northwest Field	Ritidian	Uruno	Haputo	Two Lovers Point		
SPECIES	1	1	1	1	1	1	1	1	1	1	1	$\bar{y}$	D.A.
Bittern	0.00	0.12	0.00	0.00	0.01	0.00	0.04	0.00	0.01	0.00	0.00	0.02	2.63
Broadbill	0.00	0.15	0.00	0.00	0.15	0.26	0.16	1.13	1.33	0.12	0.00	0.30	0.58
Crow	0.00	0.00	0.63	0.21	0.40	0.48	0.39	0.33	0.38	0.47	0.18	0.32	3.08
Fantail	0.00	0.00	0.00	0.00	1.60	3.19	1.54	6.01	5.62	1.20	0.00	1.74	0.34
Fruit Dove	0.00	0.01	0.00	0.00	0.02	0.06	0.31	0.34	0.37	0.22	0.00	0.12	3.27
Ground Dove	0.00	0.22	0.79	0.41	0.43	1.38	1.19	1.00	1.04	7.84	0.23	1.32	0.20
Honeyeater	0.00	0.04	0.00	0.00	0.13	0.40	0.51	0.55	0.16	0.18	0.00	0.18	1.02
Kingfisher	0.00	0.24	0.17	0.19	0.14	0.29	0.22	0.38	0.29	0.54	0.03	0.23	3.40
Rail	0.00	21.11	0.00	6.40	2.02	0.15	0.00	1.73	0.00	0.16	0.65	2.92	0.14
Starling	0.17	0.90	0.15	0.27	2.26	2.53	1.93	3.56	2.96	3.24	0.13	1.65	1.06
White-Eye	0.00	0.00	0.00	0.00	16.40	0.27	0.00	9.91	6.44	0.00	0.00	3.00	0.16
No. of Counts per Location	22	45	19	74	46	47	21	70	67	44	22	Total Counts = 477	

Table 9. Relative Abundance of 17 native and 2 introduced birds of Guam recorded at 11 locations during FY 1981. Relative abundance =
The number of birds of a species recorded, divided by the total number of birds recorded during the same count period

Species	TOL	ANS	LAJ	ANA	PAT	TAR	NWF	RIT	URU	HAP	TAN	TLP
Bittern	0.00	0.00	0.00	0.00	0.00	0.004	0.008	0.000	0.000	0.300	0.11	0.0
Broadbill	0.00	0.00	0.00	0.00	0.00	0.000	.003	0.080	0.000	0.009	0.00	0.0
Crow	0.00	0.00	0.75	0.00	0.44	0.190	0.160	0.180	0.240	0.150	0.00	0.0
Fantail	0.00	0.00	0.00	0.00	0.00	0.000	0.070	0.140	0.007	0.000	0.00	0.0
Fruit Dove	0.00	0.00	0.00	0.00	0.00	0.010	0.060	0.130	0.040	0.000	0.00	0.0
Ground Dove	0.00	0.02	0.00	0.00	0.00	0.020	.002	0.007	0.040	0.050	0.00	0.0
Honeyeater	0.00	0.00	0.00	0.00	0.00	0.030	.210	0.130	0.030	0.030	0.00	0.0
Kingfisher	0.00	0.03	0.00	0.00	0.17	0.200	.080	0.120	0.130	0.170	0.22	0.0
Rail	0.00	0.26	0.00	0.03	0.00	0.000	0.000	0.010	0.000	0.000	0.00	0.0
Starling	0.00	0.00	0.00	0.42	0.24	0.360	0.260	0.600	0.460	0.380	0.00	0.0
White-eye	0.00	0.00	0.00	0.00	0.04	0.000	0.000	0.080	0.000	0.000	0.00	0.0
Drongo	0.00	0.37	0.00	0.39	0.00	0.080	0.130	0.050	0.040	0.150	0.50	0.5
P.T. Dove	0.00	0.31	0.25	0.12	0.11	0.110	0.010	0.100	0.007	0.030	0.40	0.5
No. of Counts per Location	10	28	10	18	17	37	55	19	18	28	9	10

species were observed for a total of 48 birds.

Tarague and Uruno, both excellent habitat areas that previously have had high bird densities, apparently lost their Guam broadbill and bridled white-eye populations. The 7 remaining native bird species exist in very low densities at these locations.

Station counts at Ritidian Point and Northwest Field recorded the highest densities of native birds on Guam. However, fantail and white-eye densities were down 50% and 66% respectively at Ritidian Point and white-eyes were not recorded during any 1981 Northwest Field counts.

Philippine Turtle Dove - (Streptopelia bitorquata)

The introduced Philippine Turtle Dove population was recorded as the second most abundant forest bird on all three roadside counts in 1981. The Philippine turtle doves accounted for 9.3% of the total birds recorded during all station counts with only the Micronesian starling, black drongo and Marianas crow populations showing higher relative abundance (Table 9).

Chinese Least Bittern- Ixobrychus sinensis

No significant changes in bittern population were indicated on roadside counts during FY 1981. A significant drop ($P < .05$) in population was recorded for mean density estimates in combined locations. However, station counts may not be the most accurate method of censusing this normally silent species. The Chinese least bittern is the only native bird still commonly found in southern Guam. This anomaly may reflect genetic resistance to suspected avian diseases since this sub-species on Guam is identical to populations on the Asian mainland (Mayr 1945).

Guam Rail - Rallus owstoni

This flightless endemic species has shown continued drastic population declines. While holding its own at extremely low levels on the Northwest Field roadside counts, significant declines ($P < .05$) were recorded on the North (where no rails were observed) and the North-Central routes. The North-Central route, specifically designed in 1976 to census rails in areas of prime habitat, has shown decreases from 123.8 rails per 100 miles in 1976 to 2.2 rails per 100 miles in 1981 (DAWR 1976). Rails were only recorded at 3 of the 12 station count locations and showed a significant drop ($P < .05$) in mean density since 1980. Overall rail density has dropped 84% since 1979.

Efforts were made to census rails using playback calls over the 1981 U.S. Fish and Wildlife Service transects. Tomlinson and Todd (1973), Glaha (1974) and Holliman (1978) have reported that the method of using playback calls is the best method of locating and censusing rails which are secretive and very good at concealing themselves. Results from the call playback census indicated a sparse distribution of rails in the northern section of Guam, even in areas which have high densities of native forest bird species. Only 11 rails were observed at a total of 122 stations censused. The highest number of rails (4 birds) were recorded in the Northwest Field from 52 stations. At Ritidian 3 birds were observed, and the Pati and Uruno

transects recorded only 2 birds each. Rails were not recorded on the Tarague and Anao transects. Although no rails were observed in the Tarague transects, rails have been observed foraging in the brush areas along roadsides. In a separate survey which was used as a means of monitoring the rail population in Andersen South, 13 birds were recorded from a total of 15 stations censused during the same time period.

Jenkins (1979) stated that rails prefer brush habitats and are minimally observed in the interior of mature forests. Possibly this may account for the low numbers in the northern areas, where a majority of the transects were established in mature forest. Andersen South, a mixture of grassy, brush and scrub forested areas typical of habitat preferred by rails, had the highest recorded number of rails. Results from the Andersen South monthly call playback survey of rails indicated a mean density of .81 birds/ha, with the highest density (17.15 b/ha) recorded in January and the lowest (2.38 b/ha) recorded in September. Pairs of rails were consistently observed throughout the census period. The highest number of pairs was recorded in March (10 pairs) and the lowest (1 pair) in September. In addition, 96% (N=148) of the rails were recorded during the first 2 minutes of observation and only 4 were recorded during the last 2 minutes. Consequently, a 2 minute census period at each station may be sufficient time to survey rails using the call playback technique.

While predation on this flightless species must certainly play some role in the decline, other factors may also be involved in the birds disappearance from the southern and central portion of the island. Data from a study to determine the impact of pesticides on rails and other native birds is currently being analyzed by the Patuxent Wildlife Research Center in Laurel, Maryland. Studies dealing with suspected avian diseases remain to be fully implemented. The Guam rail population faces the very real danger of extinction within the next few years if the sources of decline are not identified and recovery plans implemented in the immediate future.

White-throated Ground Dove - Gallicolumba x. xanthonura

The Northwest Field and North roadside counts showed significant decreases ($P < .05$) in population numbers while ground dove numbers along the North-Central route remained stable at a very low level. Overall densities at station counts remained static but extremely low. Combined ground dove densities have dropped by 65% since 1979.

Once an economically important source of food, this species appears to have declined on Saipan and Tinian also (Jenkins and Aguon, 1981). Preliminary data from counts on Rota show a slightly more abundant population (DAWP field notes).

Marianas Fruit Dove - Ptilinopus roseicapilla

Carrying the distinction of being Guam's Territorial Bird, this once abundant native dove showed significant declines ($P < .05$) along all three roadside count routes, disappearing completely from the North-Central route in 1981. Fruit doves were recorded at only four station count locations, down from 5 in 1979. All counts recorded this species in extremely low numbers,

with mean density being significantly ($P < .05$) down in 1981. In direct contrast, fruit doves were one of the most abundant species recorded during station counts on Rota (DAWR field notes). Jenkins and Aguon (1981) noted that fruit doves were observed during $\frac{1}{2}$ of the station counts on Saipan and $\frac{1}{3}$ of the counts on Tinian. This once economically important species appears headed for extinction on Guam if the causes for its decline are not pinpointed and recovery programs implemented as soon as possible.

Vanikoro Swiftlet - Aerodramus vanikorensis bartschi

This critically endangered species was not observed during roadside or station counts in 1981. Restricted areas of southern ravine forest were periodically censused for swiftlets. The largest sighting consisted of 18 birds observed at Talofoto in August. Similar surveys by Division biologists at this location throughout the year recorded an average of 6 birds. Reliable reports by ranch manager Fred Mendiola record flocks of up to 40 swiftlets in this same area in 1981. A single swiftlet was observed twice at Windward Hills and a high of ten birds were recorded at the major tributary to Fena Lake in May. Two swiftlets were observed twice at Ritidian Point in August and October, the first sightings for this species in the north since 1979. It appears there may be a small colony of swiftlets in one of the many caves that riddle Ritidian Point.

The swiftlet population on Guam probably does not consist of more than 50 individuals.

Given the inaccessibility of their nests, predation does not appear to be a factor in swiftlet decline. Avian disease may be a factor although the disappearance of this species on Rota and the greatly diminished populations on Saipan and Tinian may point to the impact of pesticides on this totally insectivorous species. Guano and tissue samples of swiftlets taken in 1974 contained DDE and DDT (Drahos, 1977a). The results of a recent pesticide survey should indicate the degree of pesticide involvement and suggest areas of concern.

Micronesian Kingfisher - Halcyon c. cinnamomina

The kingfisher population on Guam continued to show significant decreases ($P < .05$) on the Northwest Field and North-Central roadside counts, while a small but significant ($P < .05$) increase in numbers was reported along the North route in 1981.

While remaining stable at extremely low densities in 1981, this once abundant species was recorded at only 8 of the 12 station count locations on Guam. Higher densities for this cavity nester were recorded during the January through June dry season, perhaps reflecting increased breeding success.

Predation by the snake, possible competition with the introduced black drongo for food resources and the increased felling of snags may account for a small proportion of population decline. Pesticides may have a major impact because of the kingfisher's carnivorous habits. Avian diseases may also be a cause of kingfisher decline.

Marianas Crow - Corvus kubaryi

Northwest Field remains the center of crow population in 1981, with a significant decline ($P < .05$) shown along the North route. No crows were observed along the North-Central route for the second year in a row. While ranking second in relative abundance and accounting for 17.6% of birds observed during station counts, crows were recorded at only seven of the twelve locations, disappearing from Anao in 1981. Average crow density for the combined locations has dropped 25% since 1979. Crows were additionally censused for total population numbers from stationary overlooks at 5 cliffline points in the north. Results from these and transect counts are currently being analyzed.

The crow is found only on Rota and Guam, and preliminary data from station counts in 1981 indicate a slightly higher population on Rota (DAWR field notes).

In addition to the possible impact of disease, pesticides, and predation, this endemic species faces the added pressure of wanton destruction as a former agricultural pest. Hunters will also illegally shoot crows because their loud calls may occasionally alert game to the presence of man. Extensive public awareness campaigns and research into the causes and reversal of population decline may save the Marianas crow from extinction.

Guam Broadbill - Myiagra freycineti

This endemic species ranks with the Vanikoro swiftlet as the island's most endangered native bird species. Never detected on roadside counts, it was recorded only at Ritidian, Uruno and Northwest Field in 1981, disappearing from Pati Point and Tarague. The broadbill has shown significant declines ($P < .05$) in density every year since the station counts were implemented. Combined broadbill densities show a 70% decrease since 1979. The species accounted for 0.8% of the total birds recorded at station locations and ranked last in relative abundance. As the broadbill's varying calls are loud and easily detected, the transect station counts should yield accurate total population estimates.

Disease and pesticide contamination would seem to be prime factors in this insectivore's decline. Broadbills have been shown to raise multiple broods and re-nest easily if eggs are lost and predation would appear to have a more minor impact (Jenkins 1981, DAWR field notes). Unless decline factors are determined and recovery programs are implemented this unique species may become extinct within the next 2 years.

Rufous-fronted Fantail - Rhipidura rufifrons urania

This small insectivore was observed in small but significantly increased numbers ($P < .05$) during the 1981 North-Central roadside counts. The fantail was not observed on any counts along the North route. The fantail population remained stable along the Northwest Field route and showed a significant increase ($P < .05$) in density in this same area in 1981. However, overall density for this species was significantly down ($P < .05$) with fantails apparently disappearing from count locations at Pati and Haputo Point and Tarague Beach. Fantails were only recorded at three of 12 station locations in 1981.

Overall fantail densities at all locations show a 65% decrease since 1979. In contrast, the Rota subspecies appears widely distributed and was commonly recorded during station counts on Rota in 1980 and 1981 (DAWR field notes).

As with the broadbill, the influence of suspected avian disease and pesticide contamination on fantail decline needs to be documented. Black drongos have been observed eating fantails several times since the drongo's introduction and data is currently being analyzed to determine whether this exotic may be harming depleted fantail populations (Drahos 1977, DAWR field notes). Recovery programs need to be implemented if this once abundant garden bird is to be saved from extinction.

Micronesian Starling - Aplonis opacus guami

This gregarious species remains Guam's most abundant native bird. No significant changes were recorded during roadside counts in 1981 and population numbers remain low along the North and North-Central routes. This species ranks first in relative abundance, accounting for 30% of the total birds seen at station locations. For the first year, no starlings were recorded on any counts at Lajuna. The starling population at Cocos Island, the only breeding population of native forest birds remaining in southern Guam, appeared stable and data from transect work at Cocos in June should yield accurate estimates of total population numbers.

Starlings on Guam may raise several broods of 2-4 birds per year and show adaptability in the selection of cavity nest sites (Jenkins 1981). These factors may enable this species to withstand the impact of pesticides, predation, and disease more easily than other native birds.

Cardinal Honeyeater - Myzomela cardinalis saffordi

This species was recorded in significantly lower numbers ($P < .05$) along the North roadside route and showed a slight but significant ($P < .05$) increase in numbers during North-Central roadside counts where the species is down 92% from 1976 levels (DAWR, 1976). Roadside counts on the Northwest Field route indicate that the honeyeater population in this area is down considerably from a high of 50.4 birds per 100 miles in 1977 (DAWR 1979). Honeyeater density remains highest in North-west Field where exotic flowers in abandoned housing areas provide excellent food sources. Honeyeaters were only recorded at half of the station locations and showed major decreases in density in the Tarague, Haputo, and Uruno areas.

As recently as 1967, honeyeaters were common components of village gardens in both northern and southern Guam (Jenkins 1981). Their precipitous decline stands in marked contrast to the abundant honeyeater population on Rota where they are one of the most commonly recorded birds at all count locations (DAWR field notes).

Pesticides may have influenced honeyeater decline since insects account for part of their diet. Predation may also be a cause, as DAWR field notes include a record of a cardinal honeyeater being found in the stomach of a Philippine rat snake on Guam. Suspected avian disease may be further decimating the honeyeater population on Guam.

Bridled White-eye - *Zosterops c. conspicillatus*

Bridled white-eyes are critically restricted in range and are nearly as rare as the Vanikoro swiftlet and the Guam broadbill. None were observed during roadside counts, presumably because of their inconspicuous coloring and scarcity. White-eyes were only recorded at Pati and Ritidian Point station counts in 1981, apparently disappearing from the North-west Field and Uruno locations. The small flocks recorded at Pati and Ritidian Points were down 83% and 69% respectively from 1980 levels. Combined densities show a 78% decrease since 1979. During the censusing of forest transects in June, the bridled white-eye was infrequently recorded in flocks of 3-5 in the area between Ritidian Point and Tarague Cave.

The Rota sub-species is similarly restricted in range and appears to be declining (Jenkins and Aguon 1981). The results of the pesticide survey conducted in May should give good indications as to the role of chemicals in white-eye population decline.

White-eyes may be more susceptible to the spread of disease than other native species due to their flocking characteristics (Jenkins 1981). Disease studies need to be fully implemented immediately in light of the concurrent declines on Rota. Unless decline factors are pinpointed shortly and recovery plans implemented, it is doubtful whether this endemic sub-species can be saved from extinction.

Studies in the Northern Marianas

The results of censuses conducted at 64 locations in all habitats on Rota in March and August, 1981 are currently being processed along with data from similar counts done in July, 1980. Density estimates from these two years of data may give an indication of population trends on Rota. Figure 3 shows the scope and location of survey work on Rota. Results are expected to be completed in early 1982.

Mist-Netting Program

In a preliminary effort to determine the presence and importance of avian diseases on Guam, 13 birds of 6 species were captured in 1981, using mist nets. Blood samples were drawn from each bird and slides made for microscopic examination. The small number of birds netted attests to the scarcity of most species and the difficulty in netting them. Four Micronesian starlings were also captured to test their adaptability to captivity for future studies. Mist-netting efforts were discontinued until avian disease proposals are fully implemented.

Endangered Species Proposals

A proposal to establish a Guam Endangered Species List consisting of twelve birds, three mammals, and three plants, was prepared and submitted to the Legislature for ratification. Action on this local list is expected early in FY 1982 and will provide added protection and focus public attention on the precarious state of Guam's native wildlife.

In addition, proposals were submitted to the U.S. Fish and Wildlife Service to place two species of bird, one species of mammal (bat) and three plants on the U.S. Endangered Species list. These are in addition to the ten bird and two bat species proposed in 1978 and 1979. We are hopeful that these species will be given federal protection in the near future.

RECOMMENDATIONS

1. Continue bi-monthly roadside counts over three routes in northern Guam.
2. Discontinue monthly station counts in favor of an intensive annual survey of bird populations using transects used in the 1981 transect census.
3. Continue to monitor the native forest birds of the Northern Mariana Islands for any trends in population decline or increase, for comparison with bird populations on Guam.
4. Implement studies designed to investigate the causes of decline in native forest bird populations on Guam.
5. Continue to seek Endangered Species listing for 12 native birds under the Endangered Species Act of 1973.

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- Report prepared by: Anne F. Maben and Celestino Aguon



The Marianas fruit dove and the cardinal honeyeater are two of Guam's endangered species.

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-18
SUB-PROJECT NO.: W-5
STUDY NO.: 1
JOB NO.: 2

JOB TITLE: The current status, distribution and natural history of Marianas fruit bats.

PERIOD COVERED: October 1, 1980 to September 30, 1981.

SUMMARY

Guam's total fruit bat population is currently estimated at 650 to 750 animals. Approximately 600 to 650 bats are found in a single colony at Pati Point on Andersen Air Force Base. Two surveys on Rota Island revealed that a higher bat population may exist than previously thought. The number of bats requested for import to Guam from other islands for human consumption declined by nearly 50% from the previous year. Most bats at the Pati Point colony were predominantly female groups. About 25% of the colony was made of a predominantly male group that remained on one side of the roost. An adult sex ratio of 54 males : 100 females and an age ratio of 27 unweaned young : 100 adult females were noted at the colony. Three known incidents of illegal hunting of bats occurred during the year.

BACKGROUND

The Marianas fruit bat (Pteropus mariannus mariannus) is endemic to the Mariana Islands and is now considered endangered on Guam. This species has been proposed for endangered status under the Endangered Species Act of 1973. The Marianas fruit bat, considered a delicacy among the indigenous people, has been under investigation by the Aquatic and Wildlife Resources Division (AWR) of Guam since 1962 (A.W.R. 1964-1980). These investigations documented a steady decline in a population index throughout the 1960's (Perez 192). Thereafter, annual surveys revealed that only a few dispersed, solitary bats remained in the prime habitat on Guam which once supported colonies containing hundreds of bats (Wheeler and Aguon 1978, Wheeler 1979). Reasons for the decline included: increase human population pressures that resulted in over-hunting and permanent habitat destruction, commercial exploitation of this food species, periodic severe typhoons, the lack of an adequate enforcement staff, and delays by the local legislature in passing protective legislation (Wheeler 1979). Fruit bats finally received full legal protection in 1973.

OBJECTIVES

To monitor the current status and distribution of Marianas fruit bat populations in the Mariana Islands.

PROCEDURES

1. Continue the systematic survey of fruit bat distribution and numbers initiated on Guam in 1978 and on Saipan, Tinian and Rota in 1979.
 - a. Conduct bi-annual surveys of Guam's northern cliffline with periodic surveys in other areas.
 1. Record bat numbers observed and search for additional bat colonies.
 2. For each bat observed record (where possible and applicable) flight elevation and direction, roosting tree species and height, part of plant eaten (flower fruit, seeds, leaves, etc.), height in forage tree, sex and age (if possible), other behavior such as vocalization, copulation, etc.
 - b. Conduct weekly intensive observations of major bat roosting colonies.
 - c. Conduct surveys on Rota, and other islands in the Northern Marianas as time and manpower permit.
2. Monitor fruit bat imports from the Northern Marianas and other island groups.
3. Maintain close liaison with other bat researchers and with government officials in other island groups as well as on Guam.

RESULTS

Bat Surveys on Guam

Biweekly surveys from cliffline vantage points were not conducted in FY 1981. Instead, counts were made once or twice monthly at Guam's only known colony sites (Table 1) where most fruit bats were thought to occur. Since some bats were hidden in thick foliage and not visible to the observer, the total number of bats at each roost was probably 10 to 20% higher than the actual number counted. The number of bats counted rose from a combined total of 204 at the North Pati Point and Weapons Storage Area (WSA) roosts on 6 and 7 April to 559 at North Pati Point on 26 August (Table 2). Immigration of bats from Rota probably accounted for the increase in Guam's population (see Report W-5-1-3).

Table 1. Locations of three known roost sites used by Marianas fruit bats at Anderson Air Force Base in FY81.

Site	Location
North Pati Point	Along cliffline, 650 m NE of the North Runway, at an elevation of 35-50 m.
Weapons Storage Area (WSA)	Along cliffline, 200 m N of the WSA, at an elevation of 90-110 m.
East Pati Point	On top of cliffline, 300 m E of the South Runway, at an elevation of 160 m.

Small numbers of fruit bats were observed throughout the year during spot checks at Tarague Beach, Jinapsan Beach, Ritidian Point, and Uruno Beach. These animals were solitary or congregated in small groups of 2 to 4 individuals and apparently never joined with the larger roosts on Pati Point. An estimated 25 to 50 bats inhabit this 17-km portion of the island's northern cliffline. In addition, Naval Magazine has a small population of 10 to 25 animals which are occasionally seen. Based on these figures, Guam's islandwide fruit bat population is estimated at 650 to 750 animals. The population has not reached this level since 1973 when 500 to 1000 bats were present (Wheeler and Aguon 1978).

Table 2. Counts of Marianas fruit bats made at three roosts on Andersen Air Force Base in FY 1981.

Date	North Pati Point	WSA	East Pati Point
13 March	127	n.c.	0
6-7 April	79	125	0
20 April	69	n.c.	0
8 May	48	n.c.	0
12-13 May	58	450	0
15 May	0	n.c.	0
22 May	0	290	0
15-24 June	0	0	n.c.
14 July	510	0	0
29 July	546	0	0
26 Aug.	559	0	0
29 Sept.	428	0	0

n.c. = bats present at roost but no counts made.

Bat Surveys in the Northern Marianas

Surveys on Rota were conducted in March and August 1981. In order to maximize the amount of land covered, survey methodology was altered somewhat from previous years (Wheeler 1980). The number of survey stations was expanded to 14 to include approximately 60 to 70% of the cliffline surrounding the "Sabanna". Observation time was reduced to 30 to 40 min per station and surveys were conducted from 0630 to 1030 and from 1800 to darkness. Roadside counts from a vehicle were eliminated. In March, 460 ha were surveyed in 8 man-hours of observation and 48 bats were counted. In August, 18 bats were seen during 7.5 man-hours of observations covering 468 ha of cliffline forest.

In the August survey, one morning and evening were spent with a local fruit bat hunter who agreed to act as a guide and assist in locating two bat roosts. One colony was said to have 1,000 to 2,000 bats while the second contained about 500. Poor weather prevented attempts to reach both sites, however each location was recorded and will be visited in the future. In addition, the hunter provided much information about the biology and behavior of bats that agreed closely with observations made on Guam. He also described the large amount of year-round hunting which still occurs on Rota.

Bat Imports

Import permits are required for all shipments of fruit bats to Guam. There is currently no limit to the number of bats that can be requested on a single permit and retail merchants frequently inflate their requests to cover the possibility that a large number of bats may be available at the supply source. The total number of bats requested for import in FY 1981 was 56,495 (Table 2), a decline of nearly 50% from the previous year (AWR 1980). Palau and Yap were again the main islands fruit bats were requested from. In mid-May, however, Yap initiated a temporary moratorium on hunting of bats. Subsequent requests to import bats to Guam from Yap were denied in order to honor the hunting ban. The large decline in fruit bat requests during the last 6 months of FY 1981 may be attributable in part to Division of Aquatic and Wildlife Resources nature education programs, portions of which was directed at conservation of bats.

Unfortunately, no figures on the number of bats actually imported to Guam during FY 1981 were available due to poor record keeping of returned import permits.

Table 3. Numbers of frozen fruit bats requested for import to Guam between October 1, 1980 and September 30, 1981.

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL
Palau	2586	7590	3051	4285	1210	1545	495	800	1015	285	802	415	24079
Yap	1240	2034	1745	2329	1955	715	1498	400					11916
Ponape	1125	3030	630	830	10	1200	115	500	1020	50	150		8660
Saipan	230	770	513	245	425	425	488	712	328	350	120	105	4711
Rota	1180	196	1021	2								30	2429
Western Samoa	300			150	200	300		200			500	200	1850
Truk	57	200		600		50	300				20	20	1247
Tinian		50			8	100		650	50			20	878
American Samoa							125			300	300		725
Total	6718	13870	6960	8441	3808	4335	3021	3262	2413	985	1892	790	56495

Natural History

Information on roosting behavior was collected by observing the North Pati Point and WSA colonies with a 20 to 45X spotting scope from March to September. Nearly the entire roost was visible from the observation point at North Pati Point; however, thick vegetation blocked close-up viewing of the WSA site.

Social Organization - At North Pati Point, fruit bats roosted in the tops of eight trees. Most bats within the colony were segregated by sex. About 70% of all individuals were organized into numerous small groups, each with eight to 35 females and two to five males. The size of each group depended on the distribution and length of branches used for roosting within the tree's crown. Normally, only 5 to 15% of the females in these groups had young. In some groups most of the females possessed young. These groups, however, were usually smaller with only five to 15 animals and were more often found in the leafless, upper branches of the roost trees. Approximately 25% of the bats at North Pati Point were found in a predominantly male group that roosted in two adjacent trees on one side of the colony. Sexual segregation within this group was not complete and about 10 to 20% of the individuals were females. The remaining 5% of the colony consisted primarily of solitary males found around the periphery of the roost.

Illegal hunting at roost sites when bats are sexually segregated may have an extreme effect in reducing the productivity of the colony. Large numbers of females are more vulnerable to being killed in a single poaching incident under these conditions.

After changes occurred in colony roosting locations (see Report W-5-1-3), social organization was temporarily disrupted. Solitary bats were noted frequently throughout the Pati Point vicinity for several days after each move by the colony.

Sex and Age Ratios - Estimates of sex and age ratios for the colony at the North Pati Point and WSA roosts were hampered by the difficulty in determining the sex of large numbers of bats during a single observation period. Identification of bats in 10 predominantly female groups produced an adult sex ratio of 23 males : 100 females, based on 203 animals. In the predominantly male portion of the colony, an adult ratio of 526 males : 100 females was noted in 68 animals. If it is assumed that 70% of the entire colony consisted of predominantly female groups, an adult sex ratio of 62 males : 100 females would be present. Thus, in a colony with 600 adults, 230 males and 370 females would be present. Perez (1972) reported the adult sex of 18 fruit bats killed by hunters at Orote Point to be 80 males : 100 females.

Most species of Pteropus have a sharply defined breeding season (Baker and Baker 1936). In species found north of latitude 4°N, young are generally born in March and April while species found south of this latitude generally produce young during September and October. However, in Micronesia, this trend has not been substantiated. In Ponape, Jackson (1962) collected unweaned P. molossinus in February, September and November, suggesting a prolonged breeding season for this species. Unweaned young of P. mariannus have been found throughout the year on Guam (Perez 1972). During this study, copulation and unweaned young were noted every month from March to September.

An age ratio of 27 unweaned young of both sexes: 100 adult (defined as weaned) females was observed at the North Pati Point and WSA roosts. This is much lower than the ratio of 50 young: 100 adult females reported by Perez (1972). However, his data were based on a small sample of only 10 adult females.

Illegal Hunting

Poaching continues to be the major factor preventing a recovery of Guam's fruit bat population. Three known incidents of illegal hunting of fruit bats occurred during FY 1981. On 21 April, two poachers with two dead bats in their possession were arrested by Conservation Officers on a moonlit night in the Conventional Weapons Area (CWA) on AAFB. On 15 June, the WSA roost was abandoned by bats and during a subsequent check of the site, 25 fresh shotgun shells were found under a small opening in the forest canopy adjacent to several roost trees. Nine days later, on 24 June at 0600, a large flock of bats was seen flying from the East Pati Point roost following a series of gunshots. Bats roosting at this location had been easily visible from the service road on Pati Point. A search made the next day revealed 19 empty shotgun shells and two dead bats. Rumors heard by Conservation Officers following this incident told of approximately 75 bats being killed. A search of the North Pati Point roost site in May revealed that poaching had been intense in the past several years. Although 127 shotgun shells were found, none were fresh; their age probably ranged from 6 months to 3 years.

In order to determine estimated dates of poaching, a study was begun to examine the rusting rates of expended shotgun shells under natural weathering conditions. Fifty shells were placed in limestone forest at Pati Point in September and will be examined monthly to check the extent of rusting and tarnishing. An additional 50 shells will be placed out in January FY 82 to make a comparison between rainy and dry season rates.

RECOMMENDATIONS

1. Survey bat numbers and distribution along Guam's entire northern cliffline once or twice annually.
2. Continue to make observations at the Pati Point colony. Information should be gathered on reproductive biology, behavior within the colony and the number of bats present.
3. Continue to survey fruit bat numbers and distribution on Rota, Aguijan, Tinian and Saipan at least once and preferably twice a year. The remainder of the Northern Mariana Islands should be visited when possible in order to obtain an estimate of the entire population of fruit bats within the archipelago. Surveys should be made during the dry season, preferably when the moon is full. On islands with large populations, such as Rota, attempts should be made to count the number of bats present in colonies. Such counts are probably more indicative of the true size of the island's bat population than are extrapolated estimates based on the number of flying bats seen during station counts. If station counts are continued on Rota, efforts should be made to include stations overlooking the forest on top of the "Sabanna". Surveys should continue in the Commonwealth of the Northern Marianas until that government has an established a wildlife management program.
4. Continue to monitor fruit bat imports and work to implement regulations controlling the trade in fruit bats. Suggested regulations would prohibit the importation of P. mariannus and place quotas on the importation of other

species. In addition, export permits or certificates of origin should be required for all shipments of fruit bats entering Guam to ensure that the bats have been legally harvested, that the place of origin is known, and that the government authorities at the place of origin are aware of the drain on their resources.

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Report prepared by: Gary J. Wiles



Marianas Fruit Bat

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-18
SUB-PROJECT NO.: W-5
STUDY NO.: 1
JOB NO.: 3

JOB TITLE: Movement patterns and habitat utilization of Marianas Fruit Bats.

PERIOD COVERED: October 1, 1980 to September 30, 1981

JOB OBJECTIVES: To determine movement and activity patterns, home range size, and patterns of habitat utilization, with an emphasis upon roost site fidelity and inter-island migration.

SUMMARY

Observations at Guam's only known colony of Marianas fruit bats (Pteropus mariannus mariannus) provided data on roost site fidelity and movements. Three roost sites were used by the colony during 8 months with one location used twice. Poaching caused two roosts to be abandoned while natural causes were implicated in the third shift. Counts of bats at the roosts revealed a large increase in numbers that appeared to be best explained by immigration of bats from Rota. One feeding area was found 5 to 6 km from the roost locations. Large Ficus trees appear to be a necessary vegetational component at bat roosts.

BACKGROUND

Little is known about the movements of Marianas fruit bats on Guam. Low population levels and the tree-dwelling habits of bats have made capture attempts and banding studies impractical. In the past, most information has come from incidental sightings and reports from local citizens (Perez 1972). Knowledge of movements, particularly between islands, is necessary in formulating proper cooperative conservation measures for bats in Guam and the Commonwealth of the Northern Marianas.

PROCEDURES

1. Develop methods and techniques for capturing, marking and instrumenting fruit bats.
 - a. Acquire a limited number of live fruit bats for experimental purposes. Bats to be maintained in a facility to be constructed under W-2-D-2.
 1. Obtain necessary federal and local permits.
 - b. Develop and test marking, banding or tagging methods.

- c. Develop and test methods of instrumenting bats with radio-telemetry equipment.
2. Implement a bat banding or marking program.
3. Implement a telemetry study of bat movement and activity patterns (to be developed).
 - a. Telemetry study to emphasize roost-site fidelity, activity patterns, inter-island migration, and habitat utilization.
 1. Habitat ordination through multi-variate analysis of telemetry and direct observational data.

RESULTS

This job was in the planning stage during this segment pending the development of an effective method of attaching radio transmitters to fruit bats. However, preliminary results pertaining to this job were obtained during other field activities (see report W5-1-2) from January 27 through September 30.

Roost Site Fidelity

Guam's single known colony of fruit bats roosted at three sites on Andersen Air Force Base (AAFB) during the 8-month period (Table 1). The North Pati Point roost received the most use. The entire colony of about 250 animals roosted there until approximately 1 March when some members shifted to the Weapons Storage Area (WSA) site. Numbers at North Pati Point declined until 13 May when only 58 bats were counted. Two days later, the site was abandoned and the full colony was located at the WSA roost. No reasons for the change in sites were determined, however, natural causes were suspected because of the gradual nature of the move.

Fruit bats remained at the WSA site until 15 June when the entire colony suddenly moved to the eastern side of Pati Point. This roost was used only briefly and on 24 June the colony returned to the North Pati Point location. Poaching incidents are thought to have caused both of these shifts. As of 30 September, the colony still inhabited the North Pati Point site.

Tradition appears to be an important factor in the choosing of roost sites by fruit bats. All of the sites used in FY 1981 have apparently been used in the past (Wheeler and Aguon 1978, AWR 1979, A. Maanao pers. comm.). Nelson (1965) and Wodzicki and Felten (1975) have noted that aggregations of other species of Pteropus will return to roost at former colony sites.

Table 1. Time periods of use of three roost sites by Marianas fruit bats at Andersen Air Force Base, FY 1981.

Site	Period Used by Bats
North Pati Point	27 January to 14 May; 24 June to present
Weapons Storage Area (WSA)	1 March - 15 June
East Pati Point	15 June - 24 June

Inter-Island Movement

The island of Rota lies 61 km northeast of Guam's northern coastline. Flights by fruit bats between the two islands may occur more frequently than previously suspected. Counts made at Guam's only known colonies rose from about 200 bats in March 1980 (AWR 1980) and April 1981 to over 500 bats in May 1981 (see report W5-1-2). Because heavy poaching of bats still continues, it is doubtful that natural recruitment alone could account for this increase. It is more likely that immigration of bats from Rota is supplementing Guam's population. Evidence supporting this belief was obtained from a fruit bat hunter interviewed on Rota. After killing 60 bats with shotguns at a roost near the southwestern cliffline of Rota in late April or early May, he and three partners reported watching the remainder of the colony, about 150 to 250 bats, fly south over the ocean toward Guam. This corresponds closely with the increase of bats noted on Guam at the same time. In addition, following the poaching incident at the WSA roost on Guam on 15 June at 0515, several hundred bats were seen flying around Pati Point in a disoriented manner while calling loudly. Many flew alone or in loose groups with two to five individuals, out 4 to 5 km over the ocean toward Rota, which was clearly visible on the horizon. All of these bats, however, appeared to eventually return to Pati Point.

Fruit bats of the genus Pteropus are considered strong fliers. Long-distance flights have been reported to occur in India (Ferrar 1934, Sterndale quoted by Walker 1968), Australia (Nelson 1965), and from Australia to New Zealand (Daniel 1975). Thus, P. mariannus does appear capable of flying between islands in the Marianas archipelago.

Location of Feeding Areas

One feeding area used by fruit bats was located in FY 1981. Interviews with security personnel at AAFB revealed that bats are frequently seen on moonlit nights flying through the forest canopy in the Conventional Weapons Area (CWA). This area is approximately 5 to 6 km west of the WSA and Pati Point roost sites.

Table 2. Abundance of plants found at the WSA and East Pati Point fruit bat roosts. (Key to abundance: xxxx = abundant; xxx = common; xx = uncommon; x = rare, only one or two individuals present; - = absent.)

SPECIES	Height (m)	WSA	East Pati Point
<u>Ficus</u> sp.	6-12	xxxx	xxx
<u>Mammea odorata</u>	6-12	-	xxx
<u>Pisonia grandis</u>	6-12	xx	xx
<u>Barringtonia asiatica</u>	12	x	-
<u>Guamia mariannae</u>	3-9	xxxx	xxxx
<u>Aglaia mariannensis</u>	3-9	xxxx	xxx
<u>Neisosperma oppositifolia</u>	3-9	xxx	x
<u>Pandanus fragrans</u>	6	x	-
<u>Macaranga thompsonii</u>	6	x	x
<u>Intsia bijuga</u>	6	x	-
<u>Cycas circinalis</u>	2-5	xxx	xx
<u>Morinda citrifolia</u>	5	-	x
<u>Microsorium punctatum</u>	epiphyte	xxxx	xxxx
<u>Pyrrosia adnascens</u>	epiphyte	xxxx	xx
<u>Nephrolepis acutifolia</u>	epiphyte	xx	xxx
<u>Polypodium scolopendria</u>	epiphyte	xx	xxx
<u>Asplenium falcatum</u>	epiphyte	xxx	xxxx
<u>Asplenium nidus</u>	epiphyte	xx	xxx
<u>Davallia solida</u>	epiphyte	xx	xx
<u>Vittaria elongata</u>	epiphyte	-	xx
<u>Asplenium laserpitifolium</u>	epiphyte	-	x
<u>Dendrobium guamense</u>	epiphyte	x	-
<u>Peperomia mariannensis</u>	herb	xxx	xxxx
<u>Procris pedunculata</u>	herb	-	xxx
<u>Pilea microphylla</u>	herb	xxx	-
<u>Mikania scandens</u>	vine	-	xxx

Terrain and Vegetation at Bat Roosts

The WSA and East Pati Point roosts were inspected after each was abandoned by bats. A visit to the North Pati Point site has not yet been made. The WSA site was located at an elevation of 90 to 110 m on a steeply sloping (30-40°) hillside between the middle and upper terraces of the cliffside. In contrast, the East Pati Point site occurred in a level tract of forest near the edge of the upper plateau at an elevation of 160 m. The substrate at both locations consisted mainly of limestone boulders and loose rocks intermixed with patches of thin soil.

Both roosts were located in mature limestone forest with Ficus sp., Guamia mariannae and Aglaia marianensis the most common trees present (Table 2). Large Ficus appear to be an important component of bat roosts. At both colonies, most bats preferred to roost in this type of tree.

RECOMMENDATIONS

1. Finalize the acquisition of all radio telemetry equipment.
2. Determine the best method for attaching radio transmitters to fruit bats by experimentally placing dummy transmitters on the captive bats in the Cushing Zoo in Tumon, Guam.
3. Develop methods of capturing fruit bats. One potential method should be to search for fruiting trees in known feeding areas and try with mist nets to capture visiting bats.
4. Pattern telemetry studies after those of Heithaus and Fleming (1978) and Morrison (1978) to determine fidelity to day roosts, periods of activity, consistency in use of feeding areas, locations of feeding areas, foraging distances and behavior, food species, and inter-island movements.
5. Continue regular observations and counts at the fruit bat colony.

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Report prepared by: Gary J. Wiles

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-18

SUB-PROJECT NO.: W-5

STUDY NO.: 3

JOB NO.: 2

JOB TITLE: Identification and Acquisition of Land Useful as Guam Rail
Habitat

PERIOD COVERED: October 1, 1980 to September 30, 1981

SUMMARY

Steps have been taken to acquire certain land areas that have value as habitat for Guam Rail.

BACKGROUND

As previously reported, the Guam rail has declined drastically in number and distribution, and is now restricted to the northern half of Guam. In order to prevent further decline, the rail has been recommended for endangered status, and most of its current range proposed as critical habitat. Some of the most valuable rail habitat is currently under military control. Some of these lands, however, have been identified as being excess to military needs and may become available for transfer to the Government of Guam. In order to safeguard these lands for the protection of the Guam rail and other native birds, the Division has been working closely with the Bureau of Planning in identifying the lands best suited as rail habitat and in preparing applications for acquisition of these lands.

OBJECTIVES

To set aside and protect valuable Guam rail habitat using existing legal authorities.

PROCEDURES

1. Identify and attempt to acquire land that provides habitat for the Guam rail.
2. Work closely with the Bureau of Planning in preparing applications for the transfer of excess military land to the Government of Guam.

RESULTS

The Division has recommended that a large area of northern Guam be declared critical habitat for the protection of the Guam rail. This species is a candidate for endangered status under the Federal Endangered Species Act of 1973. Although rails were recommended for listing in 1978, bureaucratic

and administrative procedures have precluded positive action to date. The major obstacle to overcome is the economic impact analysis now required for designation of critical habitat; hopefully the Fish and Wildlife Service will resolve this problem and action to list the Guam rail and protect its habitat on the Federal level will be taken in 1982.

The Division has worked closely with the Bureau of Planning to identify excess military land that has value as rail habitat and to prepare applications for the transfer of these lands to the Government of Guam. In excess of 1600 acres have been so identified. Draft applications have been prepared for most of these lands; as they become available, these applications will be finalized and submitted to the General Services Administration.

RECOMMENDATION

Continue with current requests for the acquisition of designated excess military land for protection of Guam rail habitat.

Report prepared by: Robert D. Anderson



Once plentiful, the Guam rail has declined drastically

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT.: FW-2R-18
SUB-PROJECT NO.: W-5
STUDY NO.: 5
JOB NO.: 1

JOB TITLE: Preparation of a Status Report and Species Management
Plan for the Vanikoro Swiftlet

PERIOD COVERED: October 1, 1980 to September 30, 1981

OBJECTIVES

To develop a status report and species management plan for the vanikoro swiftlet.

RESULTS

This job was inactive during this segment due to shortage of staff.

RECOMMENDATIONS

This job should be implemented in Segment 19 if adequate manpower is available.

Report prepared by: Robert D. Anderson

GUAM ENDANGERED SPECIES INVESTIGATIONS
PROJECT E-1-1
Section 6 - Endangered Species Act of 1973

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: ES-1

STUDY NO.: 1

JOB NO.: 1

JOB TITLE: Impact of Environmental Contaminants on Native Forest Bird Populations.

PERIOD COVERED: October 1, 1980 to September 30, 1981

SUMMARY

A study of the impact of environmental contaminants on Guam's bird populations was implemented.

BACKGROUND

Populations of Guam's native birds have declined sharply in recent years, to the point that twelve species have now been recommended for endangered status. Pesticide contamination has been suggested as a possible cause of this decline, based partially upon the facts that DDT was heavily used on the island during and after World War and that DDT and DDE residues have been found in body tissues and guano of the Vanikoro Swiftlet. This cave-dwelling insectivorous bird has declined from a population of thousands (3,000-4000 in 1966) to fewer than 200 today. This is currently one of the rarest birds on Guam.

Initial efforts to investigate the impact of pesticides upon Guam's wildlife were conducted under Job W-5-7-1 (FW-2R-18). That job concentrated upon historical review and recommended that technical assistance in developing and conducting detailed pesticide studies be obtained from the Patuxent Wildlife Research Center. That job further recommended that the pesticide investigation effort be funded through the Division's Section 6 Endangered Species Cooperative Agreement with the U.S. Fish and Wildlife Service.

OBJECTIVES

To design and implement an environmental contaminant wildlife research program that will determine the impact these substances have on Guam's native forest bird populations.

PROCEDURES

1. Review and evaluate current situation:
 - a. Current population status;
 - b. Past and present use of pesticides, herbicides and other environmental contaminants
2. Design and implement sampling and analytical program.

RESULTS

The current population status of Guam's various species of bird was monitored using roadside and point-count census techniques and is reported under Job W-4-1-3 (FW-2R-19). In general, most of Guam's native birds have continued to decline.

The historical use of pesticides has been documented through consultation with various Government of Guam and military agencies. Considerable difficulty has been experienced in obtaining quantitative information on the historical use of pesticides because of loss of records. A listing of pesticides used by the Navy since 1969 indicates that the last use of DDT occurred in 1970.

Current usage of pesticides and other agricultural chemicals has been determined largely through consultation with the Guam Environmental Protection Agency (GEPA). Their 208 Guam Water Quality Management Plan contains an informative discussion of pesticide usage on Guam and includes tables that detail the kinds and amounts of chemicals used in 1977.

In early 1981, GEPA conducted an intensive survey of the agricultural use of chemicals (pesticides and fertilizers) on Guam in an effort to update information in their 208 Plan and to evaluate the impact of agriculture on Guam's water quality. The Division assisted in this survey effort because of our interest in the impact of environmental contamination of wildlife. The results of the survey are currently being compiled by GEPA and their completed report is expected to be issued early in 1982.

As recommended in Job W-4-1-3 (FW-2R-18), the Division requested cooperative assistance from the Patuxent Wildlife Research Center (PWRC). A cooperative study was developed and Dr. Christian Grue, research biologist with PWRC, made an initial trip to Guam in March, 1981. Dr. Grue spent approximately one week conducting an initial scoping survey and consulting with various persons and agencies on Guam.

Dr. Grue prepared a detailed study plan (Appendix 1) and returned to Guam in late May to begin approximately six weeks of intensive field sampling. Dr. Grue, and a field assistant hired locally, collected samples of soil, guano, earthworms, insects, snails, toads, lizards, shrews, and other organisms from a number of locations around Guam. All specimens were transported to the Patuxent Wildlife Research Center where they were prepared for analysis. Chemical analysis was contracted to Raltech Scientific Services and is currently underway. Analysis should be completed and a report submitted early in 1982. Further pesticide investigations will be dependent upon the results of chemical analysis and the recommendations of the final report.

RECOMMENDATION

1. Base plans for further pesticide investigations upon the results of the 1981 study.

Report prepared by: Robert D. Anderson

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: ES-1

STUDY NO.: 1

JOB NO.: 2

JOB TITLE: Investigations into the Biology of the Monitor Lizard and the Philippine Rat Snake.

PERIOD COVERED: October 1, 1980 to September 30, 1981

SUMMARY

A preliminary review of literature on both reptiles was conducted. The stomach contents of 32 Philippine rat snakes were examined. In-depth studies remain to be implemented due to a lack of personnel.

BACKGROUND

The native birds of Guam evolved in a predator-free, insular environment. Over the past 200-300 years, predators such as dogs, cats, pigs, three species of rats, a shrew, monitor lizards and the Philippine rat snake have been accidentally or deliberately introduced to Guam and may now be having a significant impact on the dangerously low native bird populations.

The monitor lizard (Varanus indicus) and the Philippine rat snake (Boiga irregularis) have been known to take birds and bird's eggs on Guam and are considered efficient arboreal predators. (Uchida 1966, Drahos 1977). The rat snake in particular has been cited by local farmers as a major predator on chickens and other domestic birds since its introduction in 1947 (Quitugua, pers. comm.). Since comparisons with the snake-free Northern Marianas show relatively good bird populations, a study focusing on the little-known life history and feeding ecology of both reptiles is needed.

OBJECTIVES

To design and implement a study of the life history, feeding habits and activity patterns of the monitor lizard and the Philippine rat snake.

PROCEDURES

1. A preliminary review of literature from the Pacific Basin concerning these reptiles was accomplished using computer searches.
2. Snakes collected by the public and governmental agencies were examined for stomach contents; measurements and other pertinent information were also recorded.

Table 1. Stomach contents of Philippine rat snakes and monitor lizards examined by Division biologists from 1963 to 1981.

Philippine Rat Snake

Stomach Content	1967	1980	1981	Total
Empty		7	2	9
Native bird	1	1		2
Domestic bird		5	1	6
Exotic bird		3		3
Egg		7	1	8
Small lizard		2		2
Kitten			1	1
Rat			1	1
Rabbit		1		1
Total number of prey items =				33

Monitor Lizard

Stomach Content	1963	1964	1965	1966	1971	Total
Empty			1			1
Native bird	1					1
Domestic bird			1			1
Small lizard	1					1
Snail	2	3				5
Crab		3				3
Earthworm		1				1
Spider				1		1
Insect				3		3
Shrew		1			1	2
Total number of prey items =						19

RESULTS

A total of 32 snakes ranging from 3'4" to 8'4" were examined in 1980 and 1981. Stomach contents of snakes and monitor lizards examined since 1963 are shown in Table 1. Birds and bird eggs made up 79% of identifiable prey items in snakes and 5.3% of the total prey items in monitor lizards. The high proportion of birds and eggs taken by snakes may be due to the fact that many snakes were brought into the Division after being discovered in farmers' bird coops.

In addition, there were reports of snakes biting and killing 8 puppies and 3 kittens in 1980 and 1981. In all cases, there was no evidence that the snakes intended to eat the animals. One large snake was also discovered in the act of swallowing a child's finger as the boy slept. No ill effects from the venom have been reported in mammals as large as humans.

No monitor lizards were collected in 1981. Past data show a wide range of prey selection (Table 1). The sample size is too small to make dietary comparisons with snakes meaningful. Dryden (1965) reported monitors as having an eclectic diet. Birds and bird eggs were found by Dryden in only 3 (5.6%) out of 54 stomachs examined that contained food, echoing the Division's findings.

RECOMMENDATIONS

1. Continue to review literature on the monitor lizards and Philippine rat snakes.
2. Hire a biologist with expertise in herpetology to design and implement studies involving the life history, feeding ecology, abundance and distribution of both reptiles.
3. Consider implementing a bounty on both reptiles to obtain biological data and test the effectiveness of a possible predator control program.

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Report prepared by: Anne F. Maben.

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: ES-1

STUDY NO.: 1

JOB NO.: 3

JOB TITLE: Impact of Interspecific Competition Between Black Drongos and Native Forest Birds

PERIOD COVERED: September 30, 1980 to October 1, 1981

SUMMARY

A literature search and review was conducted on interspecific competition for food and spatial resources. A year-long study on black drongo feeding habits was implemented including gut analyses and foraging strategies. A study to determine the extent of interspecific competition for spatial resources was implemented. Data on the life history and general behavior of the black drongo on Guam was also recorded.

BACKGROUND

Population levels of Guam's native bird species have declined sharply in recent years. Along with the effects of habitat loss, pesticide contamination, predation by introduced predators and suspected avian diseases, the impact of competition by introduced bird species for spatial or food resources may be having a considerable effect on several native forest birds.

The black drongo (Dicrurus macrocercus harterti) was introduced to Rota from Taiwan in 1935 by the Japanese South Seas Development Company for insect control (Baker 1951). The drongo flourished in its new home and apparently independently crossed the 36 miles to Guam where the species was first recorded in Harmon in 1960 (DAWR field notes). By 1966, drongos had spread north to Ritidian and south to Dandan. The species' present distribution is island-wide, although drongos are primarily concentrated in the northern third of the island.

The black drongo is the most abundant bird species recorded on all roadside count routes on Guam in 1981 (Tables 1-4, W-4-1-3). The drongo on Guam also ranks first in relative abundance and accounts for 25% of the total number of birds recorded at the 9 forest census locations at which it occurred in 1981 (Tables 6 & 9, W413). Drongos are abundant and distributed island-wide on Rota, where forest bird populations remain high with the exception of the insectivorous bridled white-eye and Vanikoro swiftlet (DAWR field notes; Jenkins et. al., 1981).

The black drongo appears to be primarily insectivorous, although it has been observed to eat lizards and small birds in India and on Guam (Ali, 1970; DAWR field notes; Drahos, 1977). Its food preferences may place it in direct competition with native insectivores such as the Guam broadbill,

rufous-fronted fantail, bridled white-eye and Vanikoro swiftlet (Jenkins, 1981). Its manner of feeding from an exposed perch and its partially carnivorous diet also may place it in competition with the Micronesian kingfisher (Jenkins, 1981; Lamba, 1963). The significance of possible competition for food resources on Guam and Rota needs to be determined.

The black drongo is considered to be a highly territorial and aggressive bird species (Ali, 1979; Thyagarju, 1934; Vaurie, 1978). Drongos will swoop down and repeatedly attack the heads and backs of potentially predatory birds much larger than themselves, as well as dogs, cats, and humans that enter their territory (Ali, 1970; Drahos, 1977). Supposedly benign bird species (doves, small passerines, etc.) are reported to take advantage of the drongo's pugnacity and nest within its breeding territory for the "protection" from predators that the drongo provides (Ali, 1970; Hutson, 1946; Vaurie, 1978). On Guam, drongos have been observed to attack a wide range of birds including such relatively passive species as the Philippine turtle dove, domestic pigeons and chickens, Eurasian tree sparrows, white terns, Guam broadbills and Micronesian starlings (DAWR field notes; Drahos, 1977). Drongos on Guam have even been reported to chase fruit bats and attack and eat rufous-fronted fantails, tree sparrows, bridled white-eyes and possibly Guam broadbills (DAWR field notes). Drongos commonly mob and attack Marianas crows and Micronesian kingfishers, species known to occasionally prey on nestlings and eggs (DAWR field notes; Jenkins, 1981). A study to determine whether territorial aggression may be excluding native birds from former breeding areas and lowering breeding success is needed.

OBJECTIVES

To determine if significant interspecific competition for food or spatial resources occurs between the black drongo and Guam's native forest bird populations.

PROCEDURES

1. Literature on black drongo life history, food preferences, territoriality and role as a predator in both native and exotic habitats was reviewed through computer searches and research at mainland libraries.
2. Current population status and distribution were determined using data gathered during daily fieldwork, bi-monthly roadside counts, monthly point censuses, and the U.S. Fish & Wildlife Service's forest bird survey in June 1981.
3. Studies were implemented to determine the extent of interspecific competition for food resources.
 - a. Three to 5 drongos were collected monthly from August 1980 to September 1981 in each of three major habitats (limestone forest, disturbed open and suburban/agricultural) on Guam. Biological data including body measurements, age and sex ratios, molt, gonadal measurements and stomach contents were obtained. Prey items were identified to family whenever possible and placed in one of five size categories. The volume of total prey items for each bird was measured by

displacement and subjectively graded for gut fullness.

- b. Approximately hours were spent observing the feeding habits of drongos in four major habitats on Guam. The age and sex of each bird was recorded along with the height and type of foraging perch. The distance traveled and height from the ground of each feeding foray was estimated, rated for success and recognizable prey were recorded. Following MacArthur and Pianka (1966), the most consistently successful feeding patterns were determined. Data were gathered in a similar manner for native forest birds when encountered.
4. Studies were implemented to determine the extent of interspecific competition for space.
 - a. Observations of overt inter/intra-specific aggression were ranked as low, medium or high intensity chases with or without actual contact. Species and age groups involved were recorded.
 - b. Sixteen active nests were observed and interspecific aggression ranked to determine if drongos were excluding forest birds. Territorial behavior or evidence of nesting by native birds within a drongo's territory were recorded.
5. Incidental data on life history and general behavior were also collected for use in any future drongo control measures.

RESULTS

Data from the year-long study are currently being analyzed to reveal any significant impact black drongos may be having on Guam's native bird populations. Results are to be published as part of a Master's thesis as well as an expected Technical Report.

RECOMMENDATIONS

1. Continue to collect foraging data on possible native competitors.
2. Continue to record instances of interspecific aggression involving drongos and native birds.
3. Complete data analysis and determine the impact drongos may be having on native bird populations.
4. Determine the need for possible drongo control measures.

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Report prepared by Anne F. Maben



The black drongo is one of Guam's most common exotic birds.

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: ES-1
STUDY NO.: 2
JOB NO.: 1

STUDY TITLE: Home range and activity patterns of the Guam rail (Rallus owstoni)

PERIOD COVERED: October 1, 1980 to September 31, 1981.

SUMMARY

A preliminary literature review was conducted. Several types of traps were designed, and then tested in the Anderson South and Ritidian areas with no success. In addition, a rail survey that incorporated the taperecorded call playback method was conducted during part of the report period at Anderson South as a means of monitoring the rail population within this area.

BACKGROUND

Presently, the Guam rail population is drastically declining (Jenkins 1979, DAWR 1976-1981). Predation and heavy use of pesticides have been cited as possible causes of the population decline (Jenkins 1979). The impact of possible avian disease is also being investigated (DAWR 1981).

Though the population continues to decline, little has been published on the biology of the Guam rail. Jenkins (1979) and Perez (1968) have described the biology of the Guam rail, while others have only reported brief notes (Baker 1948, 1951; Strophlet 1946; Marshall 1949; King 1962; and Tubb 1966). More information is needed on this species' ecology and biology in order to plan future recovery programs.

OBJECTIVES

To determine the home range and activity patterns of the Guam rail.

PROCEDURES

1. A preliminary literature review was conducted on the home ranges and territories of congeneric species of the Guam rail and of other flightless birds.
2. Rails were located by the playback of taperecorded calls and traps for marking rails were set out near areas of rail response. Traps were pre-baited with snails, turkey starter pellets, dog food and fish and set for 2-3 days afterwards. Three (3) types of traps were designed that had automatic trip mechanisms and single entrances:

A four-celled trap, approximately 1600cm² was made of small-mesh chicken wire and closed via a slip mechanism. A smaller triangular trap, constructed of chicken wire, was tripped using a mouse trap. A 1296cm² single-cell trap, made of chicken wire, was closed by a mouse trap which acted as the hinge to the door.

3. Attempts were also made to capture rails using two 42 feet 1" mesh mist nets that were set at ground level and weighted with rocks. Nets were set during the first 4 hours after sunrise and rails previously located by the playback of taperecorded calls were driven towards the nets.
4. Rails were censused in the Andersen South area by the playback of taperecorded calls. Each station was surveyed for four minutes; tape rail calls were played for one minute followed by one minute of observation without playback; the process was then repeated a second time. Birds observed during the first two minutes were recorded separately from those which were observed during the last two minutes of observation.

RESULTS

Many problems plagued the trapping program thus prevented marking of birds. Without color-marked individuals, it is extremely difficult to determine the movements of a single bird in areas of high rail density. Effort during the reporting period has been concentrated on the design of traps and the type of bait.

The 4-cell and triangular trap designs were unsuccessful because their trip mechanisms failed after several days in the field and both traps were seemingly too small for the size of a rail. The mist nets proved to be too cumbersome to handle in grassy areas and allowed rails to duck underneath seemingly secure net bottoms.

The single-cell square trap performed consistantly well in the field. Capable of holding up to two rails at once, it was successfully tested on domestic chickens. A problem with all traps was the ability of rats to enter and trip the mechanisms. Single-cell square traps positioned in areas of high rail density caught 5 separate rats but no rails. The problem of bait-stealing rats may have to be solved before rail marking efforts will be successful.

The results of the call playback census are discussed in the W-4-1-3 Job Progress Report.

RECOMMENDATIONS

1. Continue literature search on congeneric species and other flightless birds.
2. Conduct intensive trapping and begin a banding program of the Guam rail.
3. Conduct a study of activity patterns and home range.

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Report prepared by: Celestino F. Aguon

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: ES-1

STUDY NO.: 2

JOB NO.: 2

JOB TITLE: The impact of predation on the Guam Rail

PERIOD COVERED: October 1, 1980 to September 31, 1981.

SUMMARY

A preliminary literature review was conducted. Stomach content of 32 Philippine rat snakes were examined. Fifty-seven dummy nests were set out in areas of both high and low rail densities on Guam and 46 dummy nests were set out on Rota. Nests were monitored for evidence of predation. In-depth studies remain to be implemented due to a lack of personnel.

BACKGROUND

The Guam rail developed in a predator-free insular environment and under these conditions evolved into a flightless species. Population numbers have fallen drastically in recent years (DAWR 1976-80) and this unique endemic is now a candidate for federal Endangered Species status under the Endangered Species Act of 1973.

Though factors such as habitat destruction, pesticide contamination and suspected avian disease may be contributing to the decline, there is evidence predation may play a major role. Over the past 200-300 years, nine major predators have been accidentally or deliberately introduced to Guam (Drahos 1977). Feral dogs, cats, pigs, three species of rats, musk shrews, monitor lizards and Philippine rat snakes are all capable of preying on the ground nesting rail and eating eggs, chicks, and in some cases, adults (Barbehenn 1962, Jenkins 1979).

Little quantitative work has been done to date to discover predators' food preferences, distribution, movement patterns, and life histories (DAWR 1980). In an effort to determine which predators, if any, may be directly impacting the Guam rail population, several studies were developed.

OBJECTIVES

To design and implement a program that will determine the impact of predation on the Guam rail population.

PROCEDURES

1. A preliminary review of literature concerning predation on birds was accomplished using computer searches.

ROTA ISLAND



Figure 1. Location of dummy nest sites on Rota Island.

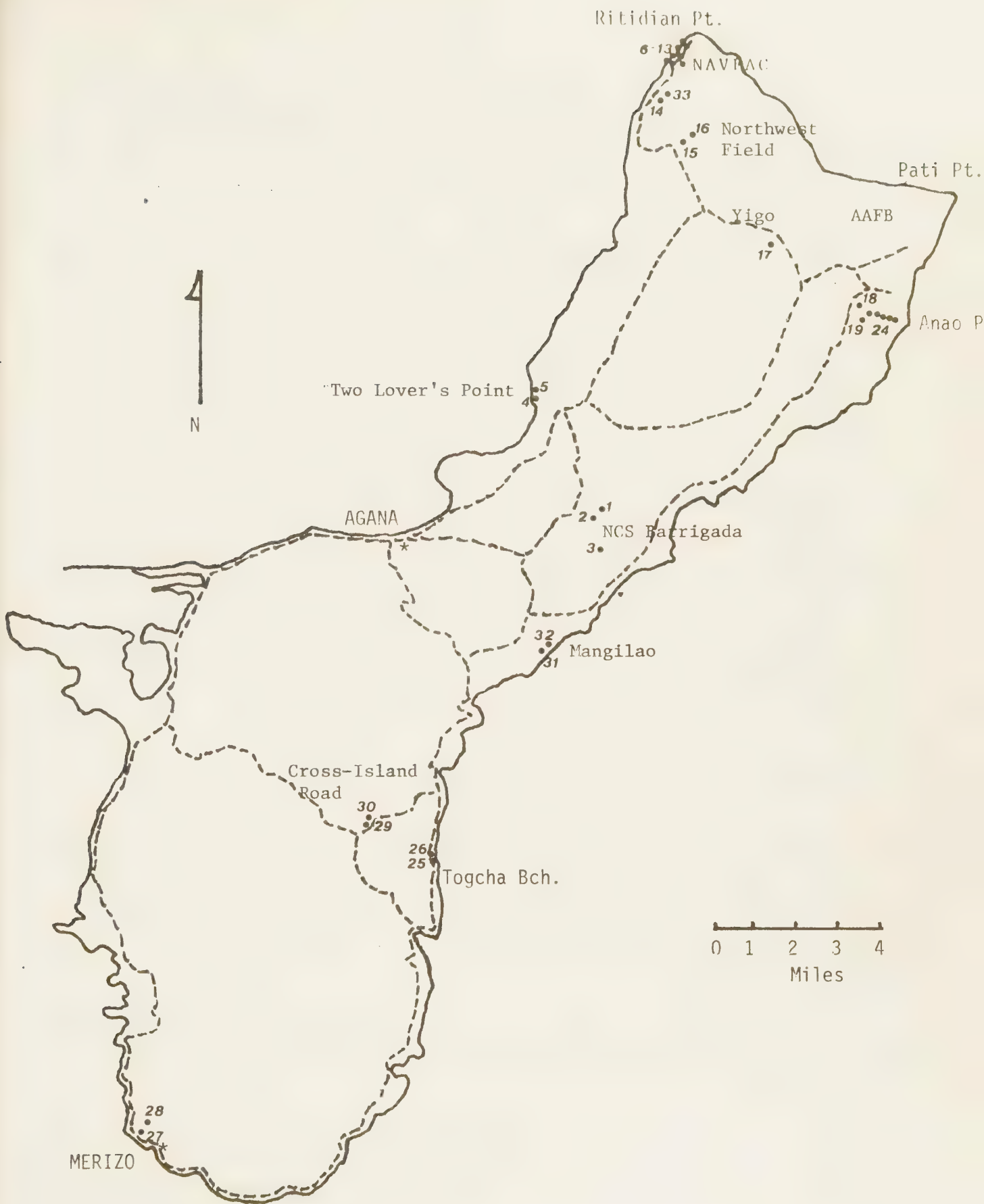


Figure 2. Locations of dummy nest sites on Guam.

2. Snakes collected by the public and governmental agencies were examined for stomach contents.
3. To test the general hypothesis that predators are decimating Guam's bird populations, artificial nests were placed in various habitats on Guam and on Rota. Rota does not have the Philippine rat snake and has a healthy bird population. Both islands share all other potential nest predators. Nest locations are shown in Figures 1 and 2.

Nests were located in limestone forest, second-growth, coastal strand and savanna on both Guam and Rota. Additionally, on Guam, nests were placed in areas with birds and in similar areas where birds are no longer present.

At each station an artificial nest made of a brown paper cup lined with fresh leaves and containing two quail eggs, was placed approximately 1.5-2 m above ground in a suitable nest site (eg., fork of a tree). Additionally, two small chicken eggs were placed at ground level in a shaded location, usually at the base of a tree. Ground and tree nests were a minimum of 5 m apart. Quail eggs were used above ground because they are more similar in size to eggs of tree nesting birds while small chicken eggs more closely approximate the size of Guam Rail eggs, the only ground nesting bird. Guam nests were checked daily for the first six days and then twice a week thereafter for two more weeks. Nests were checked daily for six days on Rota. Twenty-five tree nests and 33 ground nests were put out on Guam and 23 tree and 23 ground nests were distributed out on Rota. Comparisons were made using the G-test of independence ($P < .05$). For purposes of analysis, if at least one egg was eaten, the nest was considered preyed upon. Only data gathered during the first six days of the experiment on Guam were used for comparisons between Guam and Rota.

RESULTS

Data and discussion of the Philippine rat snake stomach content analyses are reported in ES-1-1-2 (Monitor lizard and Philippine rat snake).

Overall, predation was significantly higher on Rota than on Guam (Table 1). This was attributed to significantly higher rates of tree predation on Rota (52 percent of tree nests were preyed upon on Rota vs. 1 percent on Guam). Ground predation was not significantly different between the islands (35 percent preyed upon on Rota and 21 percent on Guam). Tree predation was higher than ground predation on Rota and the opposite was true for Guam. However, in neither case were the differences significant.

Table 1. Number of artificial nests preyed upon on Guam and Rota. N represents the sample size; Pred is the number of nests preyed on. Percent predation is in parentheses.

Location	N	<u>Rota</u>		N	<u>Guam</u>		G Test
			Pred			Pred	
Ground	23		8 (34.8)	33		7 (21.2)	N.S.
Tree	23		12 (52.2)	24		4 (16.7)	*
Total	46		20 (43.5)	57		11 (19.3)	*

* Significant at $P < .05$.

On Guam, predation was higher in areas having birds than in areas where birds no longer exist (58 percent vs. 32 percent, not significant at .05 level). Due to small sample sizes, statistical comparisons were not made between similar habitats. With and without birds or between the various habitat types. However, the data suggests that on Rota, predation was highest in second-growth and coastal strand, second-growth, savanna.

In conclusion, the results of this study show that predation rates are higher on Rota than on Guam. In areas on Guam where birds are present, predation is higher than in areas where the birds are now absent. These results do not support the hypothesis that the decline of Guam's birds is primarily due to predation. Further studies with larger sample sizes are needed to truly assess the impact of predation on Guam's birds in the various habitats.

RECOMMENDATIONS

1. Continue to review literature on predation on ground-nesting birds.
2. In conjunction with Job 1(ES-1-1, monitor lizard and Philippine rat snake), conduct stomach content analyses of major predators and determine their density and distribution on Guam.
3. Conduct a more intensive dummy nest program in areas of high and low predator densities. Develop methods of determining the exact species of predator involved in each case.

LITERATURE CITED

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- Drahos, Nick. 1977. Population dynamics of Guam birds. Unpublished manuscript.
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Report prepared by: Anne F. Maben and Julie Savidge

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: ES-1

STUDY NO.: 2

JOB NO.: 3

JOB TITLE: Impact of Environmental Contaminants on the Guam Rail.

PERIOD COVERED: October 1, 1980 to September 30, 1981

SUMMARY

A study of the impact of environmental contaminants on Guam's bird populations was implemented.

OBJECTIVE

To determine the impact of pesticides, herbicides, and other environmental contaminants on Guam rail populations.

PROCEDURES

Because this Job was conducted in conjunction with Job ES-1-1-1, procedures were the same as reported for that Job.

RESULTS

Because of the similarities between this Job and Job ES-1-1-1, and the fact that they were conducted simultaneously, results are reported under that Job.

RECOMMENDATIONS

Base plans for further investigations of pesticide impacts on the Guam rail upon the results and recommendations of the final report to be issued under Job ES-1-1-1.

Report prepared by: Robert D. Anderson

GUAM WILDLIFE DEVELOPMENT
PROJECT W-4-D-1
Federal Aid in Wildlife Restoration Act

JOB PROGRESS REPORT
DEVELOPMENT PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: W-4-D-1
SUB-PROJECT NO.: WD-2

SUB-PROJECT TITLE: Development of Office, Laboratory and Animal-
Holding Facilities

PERIOD COVERED: January 1, 1980 Through September 30, 1981

SUMMARY

The contract for the construction of the office building has been awarded and construction is underway, with expected completion by the end of 1981. Renovation of the laboratory facility is expected to begin early in 1982.

BACKGROUND

The Division of Aquatic and Wildlife Resources has grown to the size that its present quarters are inadequate to house its staff. This Development Project is intended to alleviate the problems of overcrowding and lack of laboratory facilities and storage space.

OBJECTIVES

To provide adequate office and laboratory facilities to allow for necessary increases in staff and planned expansion of the wildlife section research program.

PROCEDURES

1. New office facilities will be acquired having an appropriately sized concrete building designed and constructed. The building will be erected at the Department of Agriculture near the present office of the Division of Aquatic and Wildlife Resources. The new office facility will be used by staff of the Wildlife Section.
2. Laboratory, darkroom, and animal-holding facilities will be acquired by remodeling the existing soils lab building at the Department of Agriculture. This concrete building is currently unused and can be renovated to provide the needed facilities at relatively little expense. The completed facility will include storage space, laboratory facilities, and an outdoor flight cage for birds and fruit bats. This facility will be used primarily by the Wildlife Section.

RESULTS

The Department of Public Works has been retained as contract administrator to oversee the design and construction of the office building and the renovation of the laboratory building.

Construction of a 32'x50' (approximately 1600 sq. ft.) concrete office building is now underway and completion is expected by the end of the year.

The Department of Public Works is presently in the process of preparing the scope of work and other documents necessary for opening of the bidding procedure for the laboratory renovation. It is planned for this phase of the project to begin in early 1982.

RECOMMENDATIONS

Complete both phases of the project as soon as possible.

Report prepared by Robert D. Anderson

Law Enforcement

LAW ENFORCEMENT

The Division's law enforcement staff of Conservation Officers has been augmented during the last year with two additional positions funded by a grant from the Guam Coastal Management Program (GCMP). This brings the strength of the Enforcement Section to eight. The GCMP grant also provided for the purchase of needed vehicles and equipment.

Four of the Division's Conservation Officers attended the Guam Police Academy during 1981, graduating from the 18-week course in law enforcement in October. In addition, the supervisor of the Enforcement Section attended a special training workshop in undercover investigation techniques sponsored by the U.S. Fish and Wildlife Service and held at the Federal Law Enforcement Training Center in Glynnco, Georgia.

During the year, 35 persons were arrested for violating fish and game laws. Of the 35 persons arrested, 23 were convicted, 4 were dismissed (no prosecution), 2 prosecuted but not convicted and 6 still pending legal disposition.

Twenty persons were charged with illegal taking of deer and fifteen were charged with illegal taking of fish (use of explosives).

Based on the prosecution record, a 79% conviction rate was achieved.

Report prepared by Charles R. Bonds



Conservation Officers making an arrest

Special Programs
(Coastal Zone Management)

FISHERIES MANAGEMENT AND DEVELOPMENT

The Fisheries Management and Development Program within the Department of Agriculture's Division of Aquatic and Wildlife Resources (DAWR) has coordinated the preparation of the Territory of Guam Fisheries Development and Management Plan and has provided for the position of Program Coordinator III.

The position of Program Coordinator III was established and funded by a CZM subgrant to provide staff assistance to the Chairman of the Guam Marine Fisheries Advisory Council (GMFAC) and to coordinate living marine resource development and management efforts among affected agencies. This position is critical at this time in that the Government of Guam has no designated lead agency for fisheries development. The approach to development and management of these valuable resources has, in the past, been fragmented and ineffective.

The Territory of Guam Fisheries Development and Management Plan was produced by the Department of Agriculture using CZM funds. With the completion of this Plan, Guam now has a comprehensive scheme for the orderly development of its living marine resources that is within the capability of the local government. Through the efforts of GMFAC and the DAWR's CZM-funded position, the Plan has met with the approval of the Administration which has transmitted a resolution to the 16th Guam Legislature relative to its adoption as official policy of the local government. The resolution is presently in the Committee on Economic Development and is scheduled for public hearing in April 1982.

Eventhough the Plan is not yet official policy, progress has been made in regard to some of the recommendations. The GMFAC has been assessing recent efforts by responsible agencies in order to evaluate progress and to direct energies into areas yet to be addressed. Significant progress has already been seen in the area of data collection and analysis relative to fish stock assessments, dynamics, critical habit and the need for management thereof.

The Fisheries Program Coordinator is in the process of evaluating data and analyzing the effectiveness of the recently-passed, GMFAC-sponsored Fish and Game laws with the intention of devising resource-specific regulations relative to the harvesting of reef species. Also, being prepared for GMFAC review, is a package of proposed legislation, consistent with the Fisheries Plan, that is intended to encourage growth of the domestic fishing industry.

The Government of Guam has no designated lead agency for fisheries development and management and there are no locally-funded positions devoted exclusively to this task. Until the potential for a fisheries industry is realized, an appreciation for the need to devise and support management schemes will not be seen.

Coordination among the agencies having marine resource related responsibilities would be non-existent without the present level of CZM funding. At this point in time, the Fisheries Program Coordinator position within the Division of Aquatic and Wildlife Resources is a critical component of the Guam Coastal Management Program's efforts to provide for the management of the Territory's living marine resources.

PUBLIC AWARENESS/CONSERVATION EDUCATION PROGRAM

The Public Awareness/Conservation Program was established to develop and implement a natural resources extension program aimed at developing a "conservation ethic" among the people of Guam. Evolution from a subsistence economy to a monetary one, without the retention of cultural taboos against imprudent harvesting practices, with a concurrent improvement in fishing and hunting techniques, has resulted in increased pressure on Guam's aquatic and wildlife resources. This increase in harvest along with habitat loss has resulted in the recommendation that fifteen of Guam's wildlife species be listed as "endangered." The program is designed to increase the public's awareness of the need to manage these resources such that they are not further depleted.

Funds for the Public Awareness/Conservation Education Program were made available through the Guam Coastal Management Program for the position of a Public Information Officer (PIO) within the Department of Agriculture's Division of Aquatic and Wildlife Resources. The PIO has developed a program aimed at both school-aged children and the general public.

Before the inception of this program, there were few conservation education materials available for classroom use. The PIO has developed a series of educational materials and programs including filmstrips, slide shows, full-color wildlife flyers, a coloring book, an activity guide and puppet shows. Classroom presentations and teacher workshops have been made available to promote these materials. The response from teachers for these materials and the various presentations is an indication of the program's success in filling gaps in the existing curriculum.

A highly successful media campaign has been launched utilizing press releases, radio and television spots, and feature articles to inform the general public about aquatic and wildlife resource laws and related regulations. Public meetings, coordinated through the village Commissioners, have been well attended and have appeared to be an excellent means for increasing the environmental awareness of the general public.

Workshops were organized for the Guam Police Academy and Criminal Justice program to acquaint prospective enforcement officers and those of the legal profession with the rationale behind existing fish and game laws and the importance of their enforcement. Because of the success of these workshops, they are becoming integrated into the regular Academy curriculum.

Since the inception of this program, there has been a noticeable rise in public participation in resource protection. A marked increase in "tips" from the private sector relative to illegal fishing and hunting, followed by an increase in apprehensions, convictions, fines, and penalties for violations is one indication of the program's success. Another indication is evidenced in marked increase in the environmental awareness of the general public that has been reported by local teachers and community leaders.

